Post Office Telecommunications Journal

Published by the Post Office of the United Kingdom to promote and extend the knowledge of the operation and the administration of telecommunications

Contents

TELECOMMUNICATIONS TECHNIQUE IN EXHIBITION DESIGN
A. H. Endecott

★

BULK SUPPLY AGREEMENTS
G. H. Arnold

★

"FLYING ENTERPRISE"
W. Williamson

★

V.H.F. RADIO-TELEPHONE LINKS IN THE INLAND TRUNK NETWORK
J. H. H. Merriman and D. E. Watt-Carter

★

CENTRAL TRAINING SCHOOL OF THE P.O. ENGINEERING DEPARTMENT
H. R. Harbottle

★

PIEZO-ELECTRIC CRYSTALS
J. E. Thwaites

★

25th ANNIVERSARY OF TRANS-ATLANTIC TELEPHONE SERVICE

★

THE FIRST PRINTING TELEGRAPH
G. R. M. Garratt

★

MANCHESTER—KIRK O' SHOTTS TELEVISION RELAY

★

HARBOUR COMMUNICATIONS SYSTEM AT LIVERPOOL
Capt. W. R. Colbeck, R.N.R.

★

NOTES AND NEWS

★

Vol. 4 MAY, 1952 No. 3

Comment

THIS YEAR BRINGS, IN MAY, THE HUNDRED AND fiftieth anniversary of the birth of a pioneer in telecommunications, CHARLES WHEATSTONE.

At the age of 21 he set up as a musical instrument maker, which led him into experimental acoustics. About 1834 he was impressed with the great velocity of electric transmission in conductors, which he himself had evaluated with some accuracy. From 1837 onwards, he worked in partnership with W. A. Cooke, who had designed a telegraph instrument, towards adopting electric transmission for telegraphy.

Wheatstone's genius was many-sided. He was a skilled cryptographer: he deciphered hieroglyphic MSS for the British Museum. He invented the kaleidophone, for demonstrating the movements of sounding bodies; he discovered the principle of the stereoscope; he read papers on the physiology of vision and devised a means of analysing metals by examining the spectra of electric sparks thrown off from them. Part of his work in telecommunications is dealt with in an article in this issue.

Of a shy disposition, he yet became Professor of Experimental Philosophy at King's College, London. Governments, universities and learned societies showered no fewer than 34 distinctions upon him and ultimately he received a knighthood.

No one man can claim to have invented the electric telegraph, but we may honour Wheatstone as one who may be regarded as the founder of modern telegraphy.

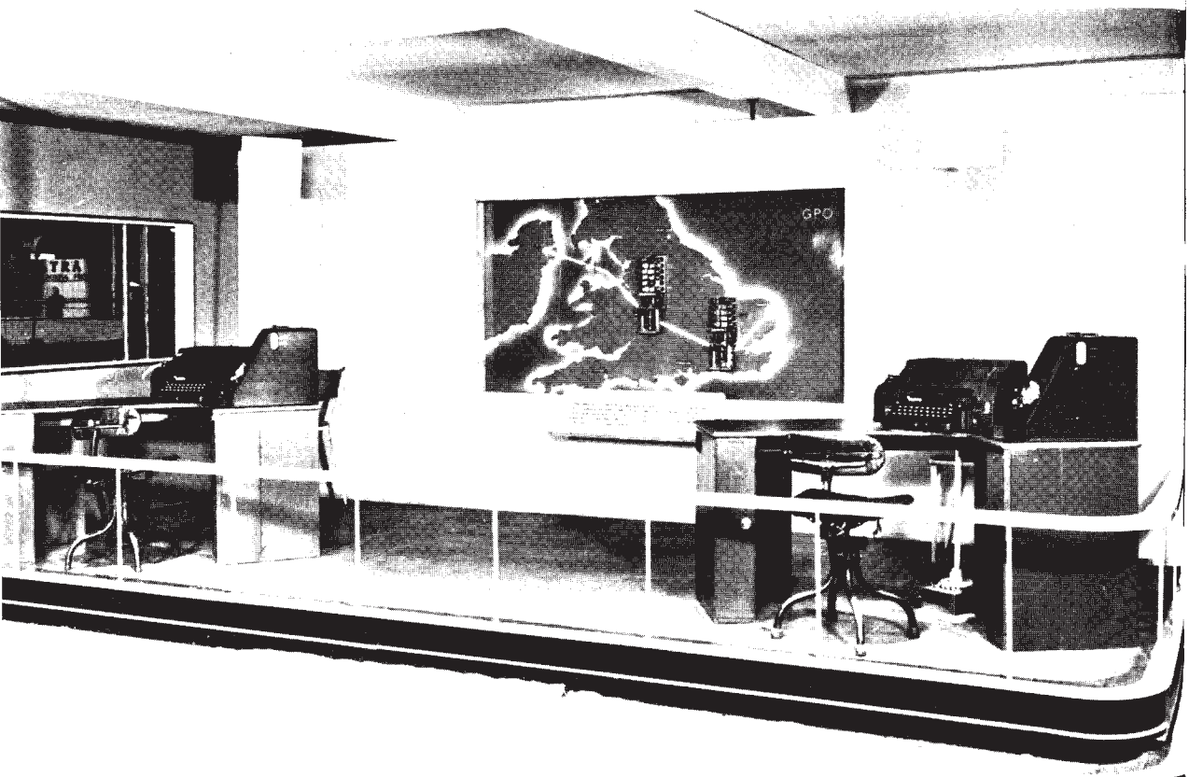
Telecommunications Technique in Exhibition Design

by A. H. Endecott, A.M.I.E.E.
Public Relations Officer, Midland Region

AN EXHIBITION AS A MEANS OF PUBLICISING Post Office services is something easily appreciated, but any connection between telecommunications technique and design in exhibition showmanship is not quite so obvious. The telephonist or the engineer in an exchange, for example, will not see at first any possible relationship between switchboard lamps or uniselectors and relays, which form so great a part of their everyday work, and exhibition displays. The connection exists, however, and is to be found in the use of telecommunications apparatus in this particular field.

When the telecommunications or circuit design technique in display work was used for the exhibits on the Post Office stand at the National Radio Exhibition at Earls Court, London, S.W.5, the displays showed, in pictorial form, the working of the automatic telegraph switching scheme (Fig. 1) and how television signals can be transmitted from London to the Midlands either by coaxial cable or over a series of radio links (Fig. 2). The lamps

Fig. 1. Representation of the automatic telegraph switching scheme



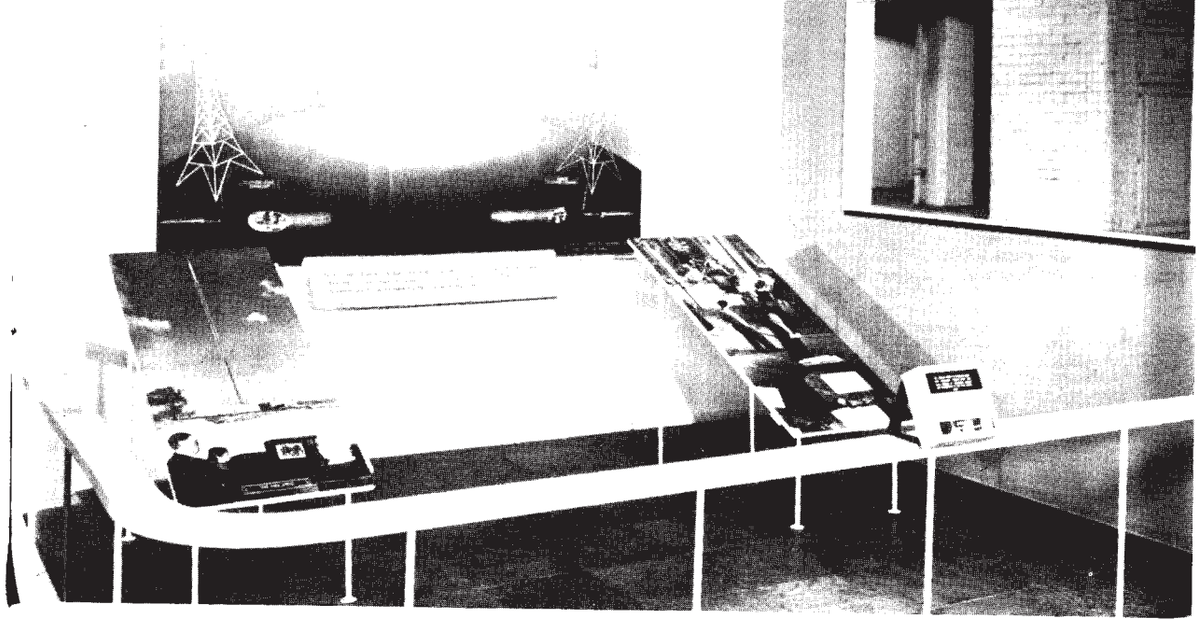


Fig. 2. Stand showing the transmission of television signals from London to Birmingham

illuminating the paths of both the television and telegraph signals on these displays were ordinary switchboard-type lamps and they were controlled almost entirely by means of apparatus of the automatic telephone exchange type. A more detailed description follows.

Automatic Telegraph Switching Display

As will be seen from the photograph (Fig. 1), the display consisted broadly of two standard single table teleprinter installations, each ostensibly identified with a particular town by means of illuminated panels, situated on either side of the stand. A map of the greater part of the United Kingdom formed the centrepiece. The demonstration centred mainly round the teleprinter on the right. The demonstrator was able, by operating one of six keys, to light up any one of the six place-names, Belfast, Glasgow, Newcastle, Exeter, Portsmouth and Norwich, on the illuminated panel, thus identifying her teleprinter with the selected town. On the map, the association between the teleprinter installation and its normal geographical location was shown by an illuminated spot.

The main switching centres for the automatic telegraph system are situated in London and Birmingham and these centres were each symbolically represented on the map by a 2,000-type selector.

To demonstrate to the public how the system worked, the demonstrator followed the standard operating procedure. First the dial key on the control panel by the side of the teleprinter was pressed. Immediately the dial lamp glowed, indicating that dialling could proceed. The audience were shown that the connection had been put through to the switching centre, by a line of lights sweeping rapidly and progressively along from the source of the message (say Belfast) to the selector representing the switching centre. As the operator followed the standard procedure of dialling the required code, so the selector on the map stepped, rotated and became connected to the next switching centre.

Circuit Established

Further digits were dialled and a final line of lamps extended to show the route of the call from one end of the country to the other. As the last connection was made, so the name panel over the left-hand teleprinter indicated the destination of the telegraph message, a lamp on the map showed its location and the glowing of the green lights on both teleprinter positions and the starting of the distant-end teleprinter motor indicated the establishment of the circuit. In this position, standard working between the two machines was demonstrated and the transmission of the message

across the country shown on the map by the flashing on and off of the whole train of lamps in synchronism with the tapping of the teleprinter keyboard.

The measure of the success of a display piece can perhaps best be judged by the simplicity with which it tells its story. If no explanation is necessary, then it can be reasonably assumed to have achieved its object. In the case of the television display (Fig. 2), the object was in the first place to demonstrate, in a simple way, and without the help of a demonstrator, how television signals generated by the cameras in the B.B.C. studios in London are transmitted as radio waves round the curved surface of the earth between London and Birmingham in five steps. The photograph mounted on the right of the display in Fig. 2 shows the inside of a television studio. In the foreground is the orchestra with the camera, lights and other properties forming a circle round the actors. The photograph on the left is a composite one, showing the mast at Sutton Coldfield and superimposed upon it a family group watching the television programme. The picture on the screen is a reproduction of the groups of actors to be seen in the studio scene. The centre panel shows symbolically a section of the curved surface of the earth standing against the sky. On this surface are mounted outlines of the

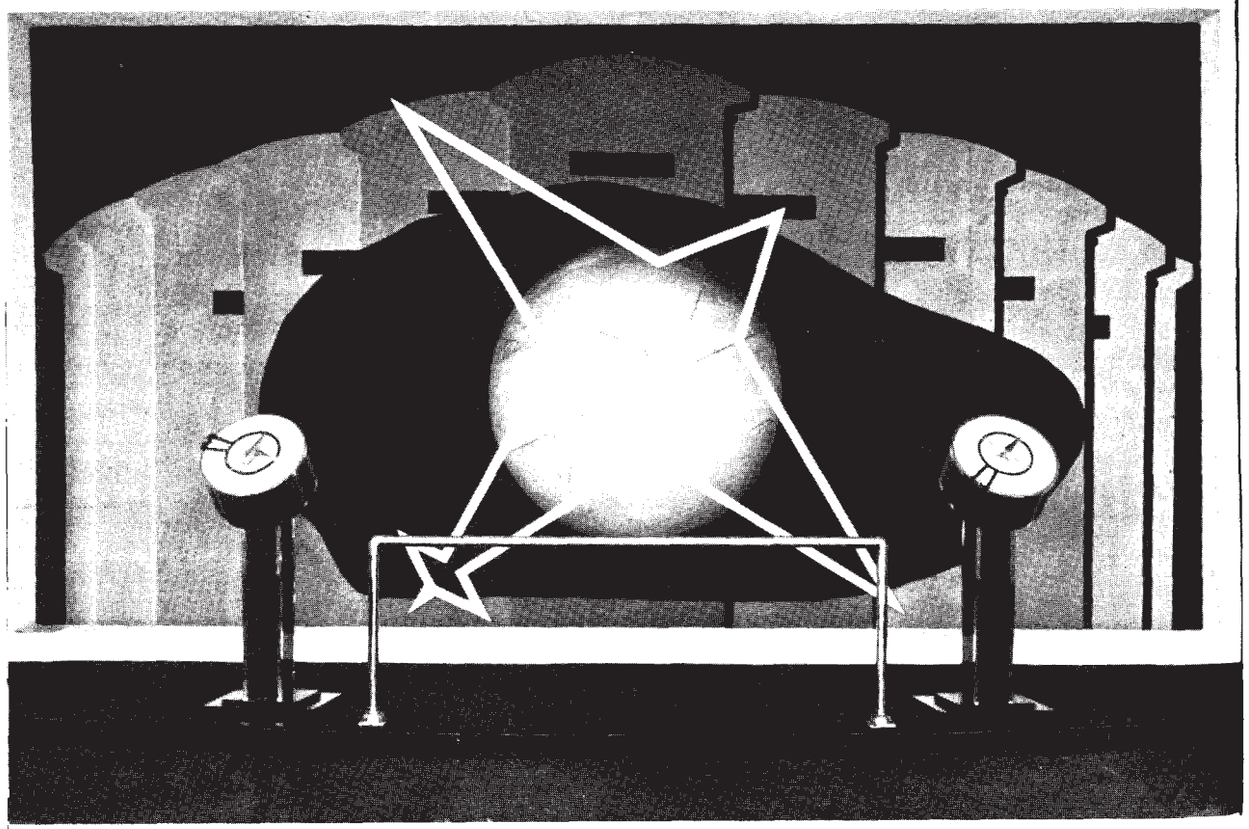


Fig. 3. A demonstration of air mail routes

masts used at the various relaying points between London and Birmingham. As the panel is made of translucent Perspex, the switchboard lamps are not normally seen. They are set out on the back of the panel in the shape of a wave form of decreasing amplitude between stations and are controlled and illuminated in such a way as to give the impression of continuous flowing movement from the studio, over a coaxial tube, up the mast, through the ether, down the distant mast and again by coaxial tube to the transmitter. Projecting apparently out of the earth, at either end of the panel, are two sections of the London-Birmingham coaxial cable. These represent the alternative path for the transmission of television signals. The operation by the public of a key mounted on the rail in front of the stand transfers the line of flowing lights from the masts, to connect studio and transmitter together via the underground cable.

An Earlier Example

Perhaps the most ambitious and potentially effective display of this kind ever to be designed was that installed at the Radio Exhibition staged at Olympia during September, 1939. The outbreak of war caused the premature closing of the exhibition and most unfortunately the elaborate display, which was designed to publicise the South African and Australian Air Mail Services, was lost when the Central Telegraph Office and adjoining buildings were destroyed by fire following enemy action on the 29th December, 1940.

The centrepiece of the display portrayed in Fig. 3 was a 6 ft. diameter sphere, representative of the world, with the routes of the air mail services shown by means of switchboard lamps. The sphere itself was rotated slowly and was suspended in such a way as to appear unsupported in space. The devices on either side and in front of the proscenium, rather like ships' telegraphs, were used by the public to select one of the twenty or so stopping places on each of the two air mail routes concerned. The arm was rotated, and as soon as it was brought to rest, a line of lights would sweep out from England, round the surface of the globe, coming to rest at the destination sought. At the same time a lamp lighting inside the selection box indicated the relative times taken by air and surface mail. It is not proposed to describe the circuit details: indeed, they now remain only in the mind of the designer, since all the records were destroyed along with the display in 1940. It is sufficient to say that almost any series of some 400 separate switchboard lamps could be illuminated at choice, and all this with only six electrical connections between the inside and outside of the sphere.

Although it is not appropriate to the telecommunications aspect of this article, it is worth recording that the rotating sphere was treated with fluorescent paint and illuminated by ultra-violet light, to heighten the impression of mysterious suspension in space.

An idea can often be conveyed to the average exhibition visitor by a symbolic display, but it must be simple if it is to make an impression and it must be dramatic if it is to attract attention in the first place. People with long experience in the exhibition business know that, although for the majority of its applications it has become hackneyed, the flashing light or a movement of some sort is the most positive way of attracting attention. Despite the commonplace usage of this medium, it can be attractively staged. With some thought on the subject it is possible to combine the tasteful with the dramatic and the use of modern telecommunications apparatus as a contribution to this end can be highly successful.

It would be wrong to conclude this brief description without referring to a series of displays that have been seen by many tens of thousands in nearly all parts of the country. These show the working of the 999 service and have been seen at Post Office exhibitions and at many put on by police and fire authorities. Here the technique descibed above has been used fully. On panels, an emergency call is traced by flashing lamps to the public exchange and thence to any of the services required. The exchange and each of the public services are shown photographically and the appropriate sound effects—exchange alarm, fire siren and police and ambulance bells—are introduced automatically at each stage. The original display was designed as a spare-time hobby by two officers on the staff of the Telephone Manager, Nottingham, and later modified in the Engineer-in-Chief's Office.

Acknowledgments

The displays described were constructed during two periods—before the war and in the past two years. Much of the construction work for the earlier display was carried out by the Engineer-in-Chief's Circuit Laboratory. The recent displays were constructed by the Post Office Factory at Fordrough Lane, Birmingham, with help and advice from the Birmingham Telephone Manager's Office.

Bulk Supply Agreements

by G. H. Arnold,
Post Office Contracts Department

FOR MANY YEARS PAST THE MAIN ITEMS of telephone plant have been purchased under "bulk agreements"; that is, agreements with groups of contractors under which the latter undertake, for a period of years, to supply, and in some cases to instal, specified types of equipment to the Post Office, and the Post Office in turn agrees with certain reservations to purchase only from the contractors in each group. Each agreement includes a schedule of prices and details the general conditions governing transactions between the parties.

The Post Office, which requires a high degree of standardisation for the efficient running of the telephone and telegraph services, was itself originally responsible for initiating bulk-agreement procedure and has undoubtedly derived great advantages therefrom. Under this procedure, competitive tendering for certain selected requirements is dispensed with and all orders are placed with the agreed group of contractors as supplies are required. The types of products purchased in this way are those that involve specialised manufacturing technique and for which the spreading of orders for the limited demand over too wide a field would be uneconomic to buyer and seller alike. These are: telephone exchange equipment; dry-core paper-insulated cables, and latterly coaxial cables; loading coils; batteries for telephone exchanges and repeater stations; telephone cords and cordage; telephone subscribers' apparatus.

Arrangements entered into under the various current agreements differ in detail, but the principal features are briefly as follows:

(*a*) The Department undertakes for the period of the agreement—usually five years—to place all its orders for the particular products with the group of contractors who are party to the agreement. Some reservations are made in respect of certain products for which the Post Office desires greater freedom of action.

(*b*) The contractors may allocate the orders among themselves as they think fit, subject to the satisfaction of the Department.

(*c*) Patents held by the contractors are pooled.

(*d*) All the contractors receive the same price rates for the goods supplied or services rendered.

(*e*) Basic prices are fixed for the term of the agreement, subject only to adjustment in respect of variations in rates of wages and the cost of materials.

Any financial advantages due to improvements achieved in manufacturing technique during the term of an agreement accrue to the contractors, but the Post Office benefits under follow-on agreements, other things being equal, in the form of reduced prices.

The bulk-agreement procedure operates to the mutual advantage of the contractors and the Department in several ways:

(i) The contractors are given reasonably long forward estimates of future requirements and can therefore plan ahead with some confidence. Delivery as required is reasonably assured and production costs are brought to a level which would be unattainable without the forward planning in the light of estimated requirements which is made possible by the bulk-agreement procedure.

(ii) Standardisation is best attained by the centralisation of production in a group of manufacturers, especially in connection with the complex apparatus required by modern automatic systems.

(iii) Research, development and design are co-ordinated and shared between the Department and contractors, overlapping effort or expense being thereby avoided.

(iv) The pooling of patents obviates a vast amount of negotiation and saves the Department considerable royalty charges.

(v) It often happens that requirements of a particular component are so small that it would not be manufactured economically if made by all the firms. Under agreement procedure, it is possible to arrange that such components are made by one or two firms only and distributed to others as required, with consequent saving in production cost.

(vi) Contract procedure is simplified and time is saved in putting work in hand.

While these advantages do not apply with equal force to all the agreements, they have proved particularly valuable in the case of exchange equipment. Two instances only need be mentioned here.

The first relates to the scope for planning for production which the agreement allows. This can be appreciated best by examining the position that would result if competition were resorted to on each occasion when supplies were needed. Under such conditions the Post Office might be in the position of requiring to place orders for half a dozen new exchanges within the space of less than a month. Under competitive tendering, no contractor could quote reliable delivery and completion dates, because he would be uncertain of the number of orders he would receive. Under the agreement, the works are allocated in advance, in accordance with the capacity of the contractors, and it has been practicable to estimate fairly closely what deliveries can be promised.

Standardisation

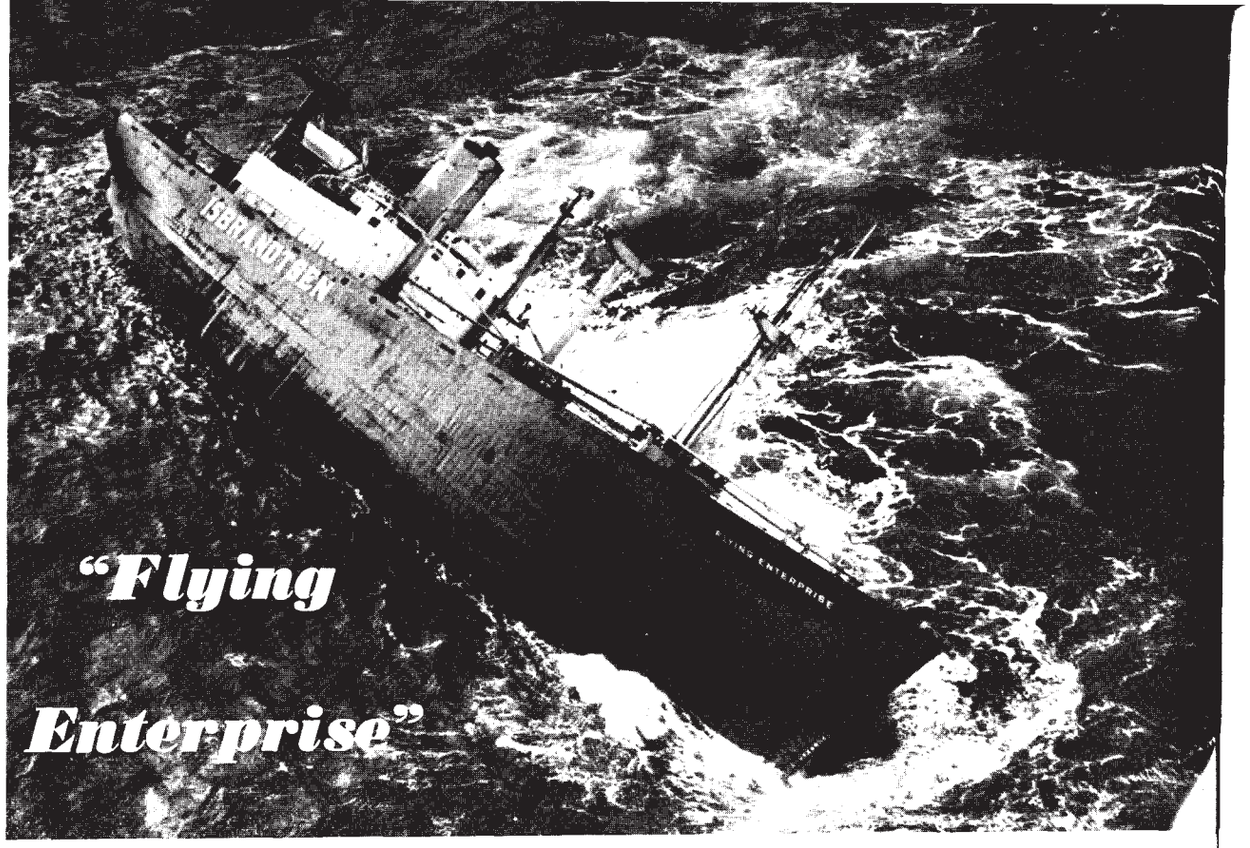
The second advantage is in connection with standardisation. Standardisation in telephone equipment is desirable not only because it reduces the amount of spare plant that must be held and simplifies the training of maintenance staff, but also because, in a nation-wide telephone system, it is essential that all exchanges shall work one with another. In large multi-office areas, such as London and Manchester, the interconnection is of a very much more closely knit nature and the use of plant of different types by different contractors would have involved the development of special apparatus and methods to enable this inter-working to take place. This, of course, would have increased the cost and the fault liability of the system as a whole.

After some years of experimenting with different systems, the Post Office decided, soon after World War I, to standardise the Strowger system and there were many differences resulting from the designs of relays and switches adopted by the several firms. After the agreement had been entered into, it was practicable to form a joint development committee, known as the British Telephone Technical Development Committee, on which all the participating contractors and the Post Office were represented. The purpose of this committee was to pool new ideas which any of the parties might develop and also to pass on to the contractors information about facilities needed by the Post Office, so that these could be provided by all the firms in a uniform manner. As a result of the work of this committee, not only have extensive changes been made in the system, but the automatic system of the Post Office has been standardised in all its essentials, so that plants of different makes work easily one with another.

It will be realised from the foregoing that the agreement policy has been of definite value to the Department, particularly when it is considered in its broader shape as a method of executing work rapidly and smoothly. During the last few years before the war, the value of orders placed with the exchange equipment contractors more than doubled and this entailed a tremendous amount of work, to both the Post Office and the contractors. In the same way, a drastic reduction in the output of subscribers' apparatus, made necessary by the financial limits imposed upon the capital expenditure of the Department in post-war years, has been rendered possible by the co-operation of the body of contractors participating in the agreements. It seems doubtful whether problems of this kind could have been handled so successfully under any other form of contracting.

As regards price, up to the period immediately preceding the war, the Department's knowledge of contractors' production costs was incomplete and prices were fixed on a combination of general knowledge and hard bargaining. The Department, however, was very conscious of the fact that it did not have access to the contractors' production costs, and this point was the subject of sustained enquiry by the Public Accounts Committee in the pre-war years. For some time the Department had urged the contractors to permit it to investigate their costs, and eventually they agreed to afford the necessary facilities at the works of one of the firms in the group in connection with the Telephone Exchange Equipment Agreement. This investigation was made in 1939, and since that date no agreement has been renewed without the granting of facilities for cost investigation. In addition, the scope of the investigations has been widened to the extent that for each agreement costs are now investigated at the works of at least two contractors, the selection of which is made by the Post Office. By these means the Department is able to satisfy itself that the prices paid are fair and reasonable.

The Bulk Agreement system came under review by the Select Committee on Estimates 1950, and after the hearing of evidence from the Post Office and the contractors, the Committee endorsed the continuance of the system.



By courtesy of the "Daily Graphic"

by W. Williamson,

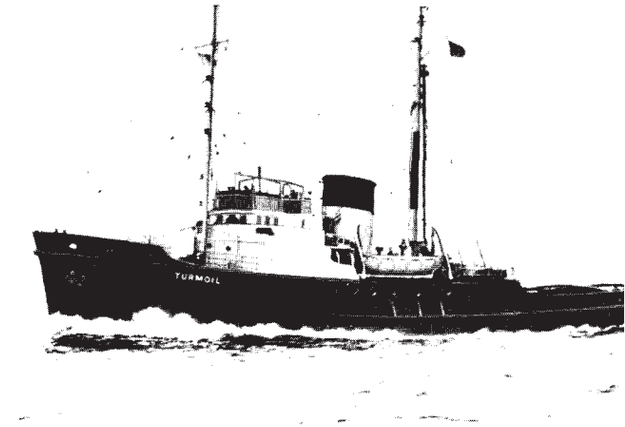
Overseas Telecommunications Department

OVER A PERIOD OF TWO WEEKS IN JANUARY, world-wide interest was focussed on the very courageous attempts to save an American vessel, the *Flying Enterprise*, which was lying helpless some 400 miles out in the Atlantic. The details of the heroic struggle of both her gallant captain and the tug *Turmoil* are now known to all the world. We in the Post Office take pride in the fact that by one of our services the Press and the B.B.C. were able to bring the hour-by-hour story to the public.

The *Flying Enterprise*, a modern vessel of 6,700 tons, was on a voyage from Hamburg to New York. On the 28th December, 1951, when some 300 miles south-west of the Fastnet Rock, she encountered one of the worst gales known for many years. The ship suffered severe damage and, with a cracked deck, a flooded hold and a shifted cargo, she took on a permanent list of 60 degrees. Her bulkheads, dividing the ship into watertight compartments, held, and she remained buoyant with that perilous list for some fourteen days.

The first intimation that the *Flying Enterprise* was in difficulties reached Land's End Radio Station at 12.49 on the 28th December—"Encountering a severe hurricane, position 49.20 North, 17.20 West, situation grave. Have 30 degrees port list and just drifting." Land's End was already dealing with several other ships in distress, but immediately took over control and advised ships in the vicinity that the *Flying Enterprise* was in urgent need of assistance. Several ships, themselves being badly battered by the gale, proceeded to her assistance and took off the passengers and crew, but the master, Captain Carlsen, insisted on remaining on board.

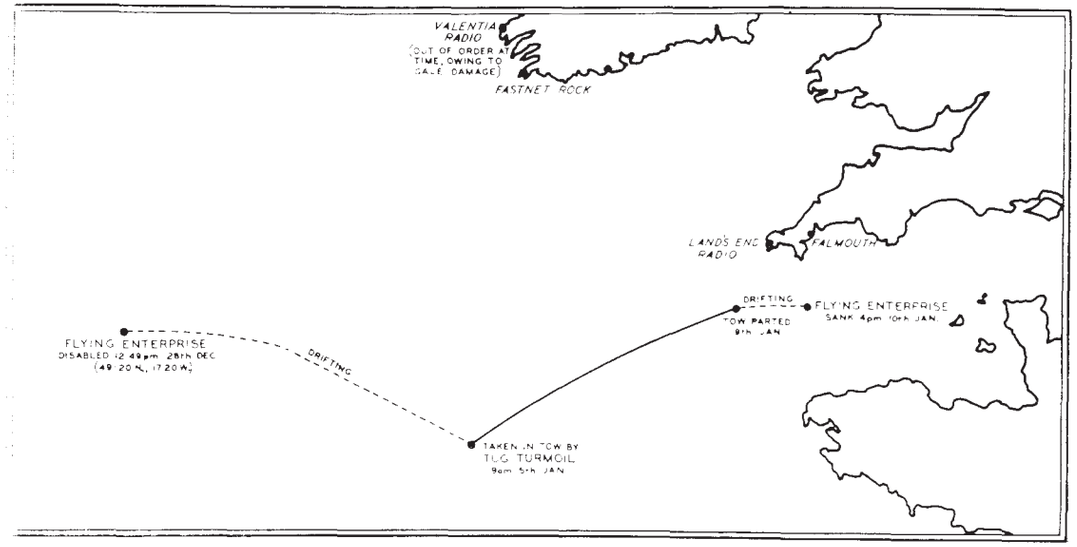
How the ship remained afloat under the terrific pounding of the mountainous seas is beyond understanding. The details of the thrilling events of the days that followed are well known and need not be described here. The lonely vigil of Captain Carlsen, later to be joined by Mr. Dancy, the Mate of the *Turmoil*—the rigging up of a low-power radio transmitter, which enabled him to keep in touch with the attendant ships (Captain Carlsen was a keen radio amateur)—the hazards of getting a tow line on board with such a heavy list—the towing of the ship and the parting of the tow rope in a second storm, when the ship was almost within sight of harbour—the final rescue of the two men as the ship sank beneath them—it was not surprising that the whole world was stirred by this epic struggle against the elements and that the demands of the



By courtesy of Overseas Towage & Salvage Co., Ltd.

Press for communication facilities exceeded anything known in the past.

Normally the distress work of the Coast Radio Stations ceases when all lives have been saved. In this case, however, the more information that reached the public, the more was wanted and the greater the load on the radio circuits at the Land's End station. Direct radio communication with Captain Carlsen was not possible, so all information from the ship had to be relayed by the ships standing by—two United States destroyers and, later, the tug *Turmoil*. From the time the *Turmoil*



The course of "*Flying Enterprise*" after disablement.

left Falmouth until she returned with the heroic Captain Carlsen, communication hardly ceased, for not only had the needs of the Press to be met, but all up-to-date information about the progress of the rescue operations had to be passed to the Coast Guard Service, the Admiralty and Lloyd's, London. In addition, there was naturally much traffic between the *Turmoil* and her owners; this was handled by radio-telegraph and telephoned directly to their offices in London.

The Press, well aware of the facilities for communication available via Land's End, made heavy demands for radio-telephone calls with the ships on the spot. It was not possible for calls to the tug to be set up until after the tow had been connected, as she was too busy with other work to accept them, and over 30 calls were on hand when communication became possible; some of these had been waiting for 36 hours. Thereafter, it seemed that the only breaks in communication were those necessary for battery charging on board.

During the following days, over 75 calls with the *Turmoil* were handled, some of the conversations lasting for over an hour. In addition, other vessels, some specially chartered by the Press and carrying newsmen and photographers, had to be catered for, and these accounted for more than 100 calls.

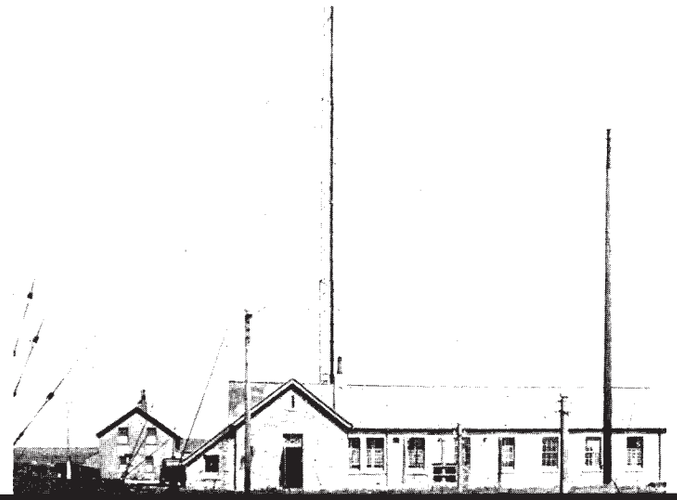
The B.B.C. included first-hand stories in their own news features. Special recording equipment was despatched to Land's End Radio Station and calls from ships on the scene were recorded for inclusion in the Home and Overseas services. One recording of particular interest was that of Captain Carlsen's voice from the *Flying Enterprise* relayed by the American destroyer, *Willard Keith*. This ship fortunately had the necessary magnetic-tape recording apparatus on board and a very interesting story, involving double recording and transmission, was obtained by questions and answers relayed by the destroyer. The records were not only used by the B.B.C., but were also flown to the United States and Denmark and broadcast over their nation-wide networks.

During the last moments of the *Flying Enterprise*, on the 10th January, the minute-by-minute reports from the tug and destroyer, and also from R.N.L.I. lifeboats, which had joined the company of ships in the final stages, were passed to Lloyd's in London by teleprinter manual switching to the Burnham station and thence by direct teleprinter. These messages were received at Lloyd's and posted in the Underwriters' Room within ten minutes of leaving the ship.

All the messages and calls that have been referred to were, of course, additional to the normal work of the Land's End station; this work continued without interruption throughout the period of stress and strain due to the *Flying Enterprise* incident.

As the tug *Turmoil*, with the *Flying Enterprise* in tow, neared Falmouth, this small old-world port became the centre of operations of newsmen of many nationalities. The Falmouth Head Post Office provided a news room overnight, with special facilities for the transmission of photographs and for handling the heavy load on the trunk telephone system for calls not only to London but to places on the Continent and in the United States of America. Many tributes were later paid to the Post Office for the splendid co-operation given to the Press by the telephone and coast radio service.

Land's End Radio Station



A typical scene in the Shetlands—Weisdale *(Photo, by courtesy of Scottish Tourist Board)*

V.H.F. Radio-Telephone Links in the Inland Trunk Network

by J. H. H. Merriman, M.Sc., A.Inst.P., A.M.I.E.E., and D. E. Watt-Carter, A.M.I.E.E., Engineer-in-Chief's Office

COMMUNICATION WITH ISLAND COMmunities has always presented a challenge to man's ingenuity and initiative. In the United Kingdom there is a special interest in this matter, since there are over 100 inhabited islands off our coasts, ranging from the large islands like the Isle of Man, with a population of some 100,000, to islets that bear the full force of the Northern Atlantic storms, such as Foula, the far outpost of the Shetlands, which has about 150 inhabitants, or Pabbay in the Hebrides, with its population of three. The larger islands and island groups have maintained their communication by regular boat services, and during the past twenty years or so the use of aircraft has become more common.

Communication with the smaller islands, however, is infrequent and dependent upon the whim of tide, wind and ocean swell, being usually achieved by open boat; yet it is in conditions of extreme weather, when transportation fails, that communications are so often most urgently required, to deal with such emergencies as critical illness, shipwreck or shortage of fuel or food. The provision of a telecommunication service to island communities has therefore engaged the attention of the Post Office for some time past.

In the middle and towards the end of the nineteenth century, undersea telegraph cables to the larger islands were laid and the basis of a telecommunications service provided. The routes such cables had to follow, however, were generally either routes lying across much-frequented shipping lanes or across channels where there were unusually high variations in tidal flow and an associated rocky bottom. The life of the cable was found to be relatively short, on the one hand owing to fouling by ships' anchors, and on the other to abrasive movement of cable on rock.

It was not accidental, therefore, that the first recorded uses of "wireless" in the G.P.O. were

intimately associated with attempts to establish communications between mainland and island. For example, there is the record of experiments carried out in May, 1897, by the "young Italian electrician", Marconi, between Brean Down, an island in the Bristol Channel, off Weston-super-Mare, and Lavernock in Glamorgan, under the active encouragement of Sir William Preece, then Engineer-in-Chief of the G.P.O. Then, around 1900–1904, there were many attempts to provide wireless telephony circuits to lighthouses. In one of these experiments, during which Oliver Lodge cooperated with the Post Office, successful attempts were made to establish communication between Cemlyn, in Anglesey, and the Skerries lighthouse, off Holyhead. We find, in a letter dated 19th July, 1900, that Lodge suggested: "*. . . what we want is a magnifying microphone . . . another vibrating arrangement or dancer . . . and a sluggish relay . . . by this means spurious signals can be avoided . . .*".

These experiments were carried out under the general superintendence of the Engineer-in-Chief's Office of the Post Office. In his report on the performance of this link, the Engineer-in-Chief's technical officer wrote, on the 5th January, 1903, that "*. . . when the tide is low . . . the speaker has a strong voice, the listener has good hearing and is used to the accent of the speaker, it is possible to follow a conversation with the telephone receiver almost half an inch from the ear . . . but as the operators speak with a strong Welsh accent, it will be readily understood that a stranger . . . would have some difficulty in following a conversation . . .*". As an indication of the unchanging characteristics of human nature, present officers of the Department may fine a ring of familiarity in the minute of the Superintending Engineer, North Wales District, dated 22nd January, 1903, to the Engineer-in-Chief, stating: "*It is desired to close the Skerries Works Order as soon as possible, and in order to do this I shall be glad to learn whether the Engineer-in-Chief's technical officer has yet concluded his experiments*".

Man-handling test equipment for radio link in Orkney

In the years that followed, methods of cable armouring and transmission techniques progressed steadily, to such a degree that telegraph and in many cases telephone facilities could often be provided. It became apparent, however, that there would remain certain cases where the handling of cable ships would be so difficult, or the maintenance of the cable so costly, that radio communication would be the only alternative. In some cases, too, the provision of a radio system as an alternative routing, to avoid complete loss of contact during cable fault conditions, was considered desirable. The provision of radio systems for telephone communication over short distances did not become economically practicable, however, until the period 1930–1935, when valves and techniques exploiting wavelengths much shorter than those in general use were developed. These shorter wavelengths allowed designers relative freedom to plan V.H.F. (very high frequency) systems without fear of interference from other stations, and also permitted the use of much lower powers than would have had to be used at longer wavelengths. It was also possible, at these wavelengths, to erect aerials on relatively small telephone poles, which would "beam" the signals towards the distant station in the manner of a searchlight beam, only some few per cent. of the power "spilling over" outside the beam angle of eight or ten degrees. To have achieved this same beam width at longer wavelengths would have required aerial systems supported by more complicated and costly steel lattice masts some 150 ft. or more in height.

Let us now consider in greater detail the setting up of a V.H.F. link. The need for telecommunication services to a particular island having been established, consideration has to be given to the most appropriate method of provision. If by radio, then the system chosen will be of one of the two standard types, either:

(i) providing up to 24 speech channels and capable of being fully integrated with the trunk network; or

(ii) capable of providing one speech channel and having certain restrictions on its connection to the trunk network.

The first type has been developed to take the place of one or more complete repeater sections on 12 or 24 channel cable systems and will give a performance complying with the requirements of the C.C.I.F. (Comité Consultatif International Téléphonique)* over links of up to 100 miles in length. Any one or more of the telephone channels so provided may be used for the transmission of multichannel V.F. telegraph systems. In order to make the radio system as proof as possible against interruption due to faults, duplicate equipment is installed, with a remotely controlled change-over system.

Transportable field testing equipment in action in the Hebrides

The second type of equipment has been developed to provide a subscribers' telephone service in remote localities where no public electric power supply exists and where the calling rate is low. The equipment enables a subscriber or possibly a small manual exchange to be connected to any type of manual or Strowger-type automatic exchange over links of up to about 20 miles in length. It has been designed to have an endurance of about 4–6 months without replacement of its battery power supplies and, being necessarily as simple as possible, has no reserve equipment.

In both types of equipment, the principal aim in design has been reliability, since both types have to operate on an "unattended" basis. The importance of this is obvious when it is remembered that a maintenance visit to, for example, the island of N. Ronaldshay requires an open-boat crossing of an exposed channel. The boat operates only two days a week and there is always a risk of inability to return because of mounting seas. In fact, for the sake of a few hours' work, the maintenance officer was once marooned on the island for a fortnight.

The first step in setting up a radio link of either form is to select the sites of the two terminal stations. A number of factors have to be taken into account, if a reliable and satisfactory link is to result. One inescapable requirement arises from the quasi-optical characteristics of radio wave propagation at the wavelengths used for these links. That is to say, the radio signals travel in straight or nearly straight paths, so that the presence of obstacles in their path, such as the spur of some local hill or even high trees, gives rise to radio "shadows", or areas where the received signals are relatively weak. Although it is possible to forecast and allow for some of the effects of path obstructions, the radio engineer endeavours to locate his sites so that they can "see" each other, in the radio sense. It is a tribute to the accuracy of the Ordnance Survey of the United Kingdom that the various alternatives to meet this requirement can nearly always be selected to within quite narrow limits and frequently pinpointed with confidence from map inspection and contour plotting. This, of course, narrows down the field search and saves much time. Incidentally, the lack of such accurate maps is one of the factors that increase the difficulties of planning such links in relatively undeveloped areas overseas.

The surfaces of both sea and earth act as very efficient reflectors of radio waves at the frequencies employed, and this has a fundamental influence on

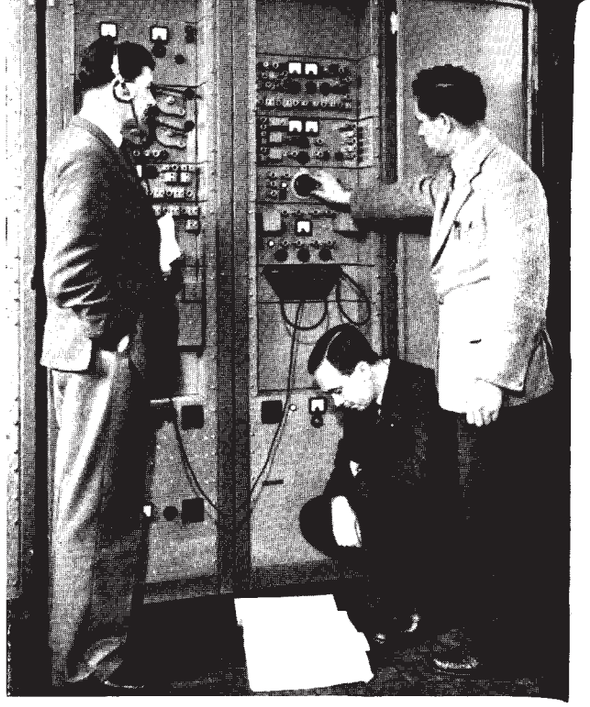
* C.C.I.F. is used to denote the International Telephone Consultative Committee, to avoid confusion with the existing abbreviation C.C.I.T., denoting the International Telegraph Consultative Committee.

the choice of both the position and the topographical features of a desirable site.

If properly exploited, the reflecting properties of the earth can be used to advantage in securing the best results from the aerial systems. The radio-frequency energy leaves the transmitting aerial or arrives at the receiving aerial, in general, in two useful directions: one is in a direct and more or less horizontal line joining the two aerials, and the other is via the reflecting ground plane in the immediate foreground of the aerial. The radio engineer tries, therefore, to find sites that have as nearly as possible a uniform gradual downward slope in the direction of propagation for at least 300 feet in front of the aerials. With aerials properly designed to take advantage of the slope characteristics, it would be possible, under ideal conditions, to obtain a resultant signal at the receiver four times as large as that in the absence of reflection from the ground plane. Such figures are rarely achieved in practice, since changes in slope or unevenness of surface scatters the reflected waves, but it is nevertheless possible to get really worthwhile improvement by attention to this aspect of site selection.

Site inspection and consideration of these technical factors usually reduce the number of possibilities to two or three sites for each station. They will almost certainly be on high ground and hence relatively inaccessible and so placed as to sample the worst degrees of wind, storms and snow that the district has to offer. If called upon to verify all this during the depths of winter, as is usually the case, the engineer bears his lot with fortitude, comforted no doubt by the knowledge that whatever money may be required for access roads, adequately weatherproof buildings, power and telephone cables, at least he has no charges to bear for the use of his communication medium, the ether.

At this stage, the technical, economic and operational pros and cons of each site are weighed and the choice narrowed still further. The next step is to carry out field-strength measurements between the two or more most promising sites. The purpose of these tests is to verify that the theoretically predicted propagation path is in fact satisfactory and to gather sufficient evidence about the disposition of field strength over the sites to enable the permanent aerials to be correctly designed and positioned. The equipment for these tests includes a mobile transmitter, complete with local power supply, and a means of measuring the transmitted



Part of the internal equipment of a multi-channel V.H.F. radio station

radio-frequency power, high-sensitivity receivers with linear characteristics and a signal generator for receiver calibration. An additional transmitter and receiver is also required for two-way communication between the sites. The test aerials take the form of half-wave dipoles of robust construction, connected to the equipment by flexible feeder cable to enable them to be moved about easily over the site. The aerials are mounted on light tubular masts some 30 to 40 feet high, which are easily and speedily erected by the testing staff. Needless to say, getting all this equipment to a remote site, often without any roads, sometimes presents difficulty, and transport of more than ordinary robustness and agility is essential.

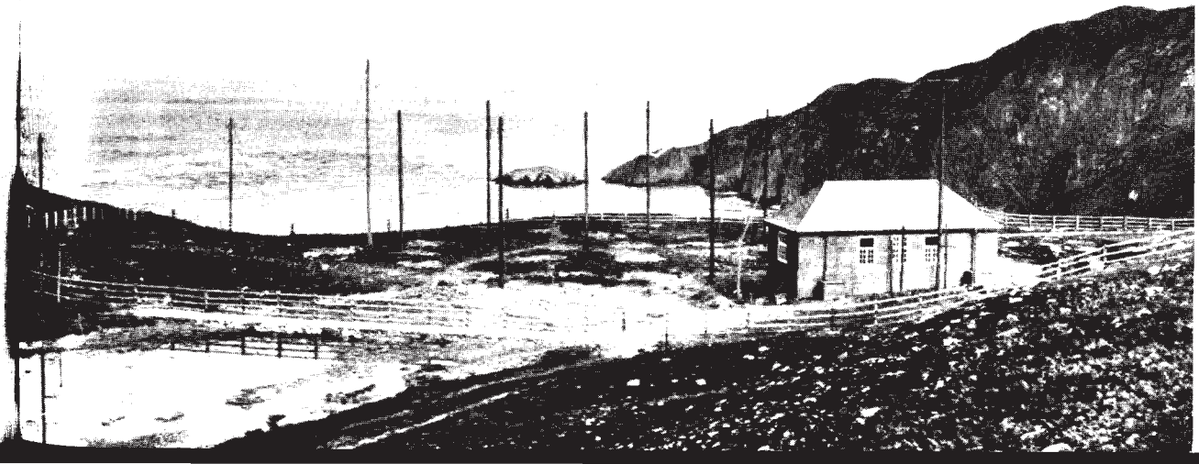
The testing procedure is, briefly, to erect the test aerials at a number of selected points in turn on both transmitting and receiving sites and to measure the received signal as the height of each aerial above ground level is varied. By this means, a series of "height gain" curves is obtained, which, when interpreted in conjunction with a careful survey of the ground in front of the site, in most cases provides adequate information from which to choose

the best position and design for the permanent aerials.

A variety of different types of permanent aerial systems could be used to give the desired performance, but for some years the Post Office has favoured the rhombic aerial, on account of its extreme simplicity and mechanical strength—very necessary on exposed sites subject to very high winds—ease of adjustment and economy in its use of supporting structures and materials generally. It has now almost entirely superseded the older and mechanically more complicated "broadside" arrays of dipoles known as Koomans arrays. The method of feeding the aerials has also undergone some change with the use of higher frequencies. Open-wire lines are quite efficient and satisfactory up to about 60 Mc. s., but above this frequency irregularities in them due to such unavoidable imperfections as bends, insulators and even imperfect regulation of the wires begin to cause trouble, and it is now the practice to use coaxial feeder cables for operation over 100 Mc. s. A matching transformer is necessary to convert the balanced impedance of the aerial to the unbalanced 75-ohm impedance of the cable, and this is mounted in a hermetically sealed cast aluminium box as close as possible to the feedpoint of the aerial. It is also most desirable that the lengths of all feeder cables should be kept as low as possible, as otherwise some of the advantages of the high-gain aerial system would be forfeited in increased cable attenuation.

The installation of the internal equipment at a typical multi-channel radio system is shown in the accompanying illustration. The equipment is designed to operate on a wavelength of about 2 metres —more specifically, on frequencies in the range 156 to 184 Mc. s. The 24 channels are modulated as a group on to the radio-frequency carrier, the assembly of individual channels into this group being carried out at the appropriate terminal station in the associated line network. In some cases, however, at the island end of the link, this line terminal equipment is located at the radio station for ease in maintenance. The modulation of the group of 24 channels on to the radio-frequency carrier is by frequency modulation (F.M.). This enables significant advantages to be obtained in comparison with earlier systems using amplitude modulation (A.M.), by reduction of sender power to 10 watts and a consequential increase in reliability. The reduction in sender power is ten to one, without loss of performance, and the necessary high circuit stability can be achieved much more readily; so much so that over a range of incoming signal strengths of up to 1,000 to 1, the output level from the radio system will depart by less than one tenth from its nominal value. In order that the operating frequency allocated to a particular link may be rigidly adhered to, the mean radiated frequency is compared with that of a signal of stable frequency derived from a quartz crystal controlled oscillator. Should there tend to be any divergence between the mean radiated frequency of the sender and this local sub-standard, then automatic compensating and correcting circuits come into action to reduce that error, so that the mean radiated frequency is plus or minus one part in ten thousand of its

A typical multi-channel V.H.F. radio station

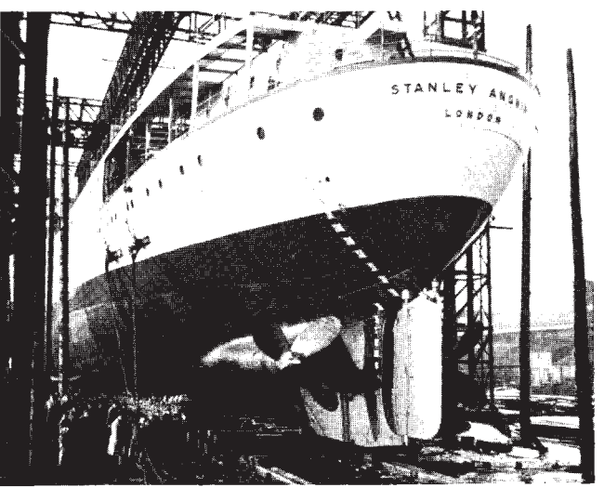


nominal value. Since the location of the radio station is determined largely by radio propagation conditions, it is generally found that it is well removed from any convenient maintenance or supervisory base. Arrangements are therefore made to extend over a cable pair, to the nearest convenient point (usually either a staffed repeater station or the test desk of an exchange), signals indicating the condition of the radio equipment and to provide means for remotely changing over from main to standby equipment. In all stations, arrangements are made to preserve continuity of service in the event of failure or interruption in the public power supply. A standby power supply is provided in the form of a small Diesel-driven generator. This is designed to start up and connect itself automatically to the radio equipment when the mains supply either fails or departs from pre-arranged voltage limits and to shut down when the mains supply is restored. It is also customary to arrange for a signal to be given at the remote control point that the generator is running and so ensure that an unduly prolonged mains interruption is investigated before the fuel supply becomes exhausted.

It has been found that in the circumstances prevailing in the United Kingdom, where access to staffed engineering positions is fairly easily available, this limited form of remote control has proved very satisfactory and considerably simpler than a fully automatised change-over system, for which supervisory signals would still have to be supplied.

In considerable contrast to the above is the simple compact subscriber's radio-telephone equipment recently developed in the Engineering Department. The problem of providing a radio-telephone service to remote subscribers depended largely on the provision of a suitable power supply. The radio "phonogram" links provided since 1935 have depended, in places, on wind-driven generators. The main difficulty with these is their liability to damage under gale-force winds. Hence, the new subscribers' radio-telephone equipment has been built to use primary batteries, which, at a calling rate of about twelve 3-minute calls a day, are designed to last some 4–6 months. The development was made possible also by the availability of a range of miniature valves, some of which were originally introduced for deaf-aid appliances. The equipment, being small, compact and housed in sealed, waterproof, metal cases, can be located in any convenient position not more than 100 yards or so from the aerials, which latter, being also small and similar to the familiar television H-dipole, can be mounted on a single self-supporting pole.

As a first stage, the earlier radio "phonogram" sets are to be replaced by the receiver equipment. In the second stage, as equipments become available, a programme of provision of service to islands hitherto not linked with the trunk network will be initiated.



New Cable Ship

A 2,500-ton cable ship for Cable and Wireless, Ltd., was launched on the 11th February at Newcastle-on-Tyne. The ship was named *STANLEY ANGWIN* by Lady Angwin after her husband, Sir Stanley, Chairman of the Commonwealth Telecommunications Board and former Chairman of Cable and Wireless, Ltd.

An article on the construction and equipment of the ship will appear in this journal later in the year.

Photograph by courtesy of Messrs. Swan, Hunter & Wigham Richardson, Ltd.

LONDON TELECOMMUNICATIONS REGION, LONG DISTANCE AREA

This Area is unique in that it has no size—a mere 700 trunk subscribers, no Accounts, Sales or External Engineering Divisions. It makes up for these omissions by having Kelvin House, one of the latest exchange buildings, and the best known exchange building in the country, Faraday Building. This is an agglomeration of four buildings, containing, in its 10 acres of floor space, three long-distance automatic units and 1,310 positions, of which 190 are for completing continental traffic. This centre, together with the International Radio Exchange and three trunk demand control centres, comprise the Area, which is being increased by the addition of two more automatic units. The Area Office occupies Wren House, in St. Paul's Churchyard.

In this Area are terminated 47 radio-telephone links, 365 continental lines and 12,895 inland and toll lines. The staff numbers over 5,000, of whom 4,000 are telephonists and allied supervising grades.

Left to right: R. F. HOLLIDAY, Area Engineer; R. C. DEVEREUX, Area Engineer; A. L. GODDEN, Chief Traffic Superintendent; E. S. RUSSELL, Chief Traffic Superintendent; W. T. J. DONOVAN, Telephone Manager; W. G. AYLETT, Chief Traffic Superintendent; L. R. SMART, Acting Chief Clerk.

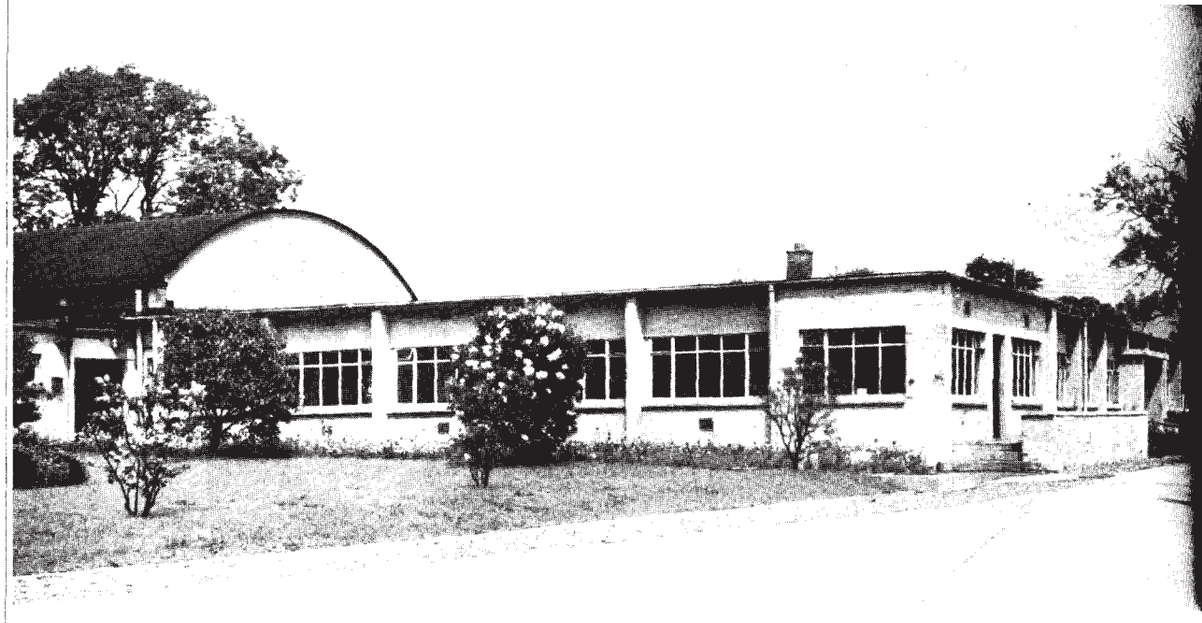
BOURNEMOUTH TELEPHONE AREA

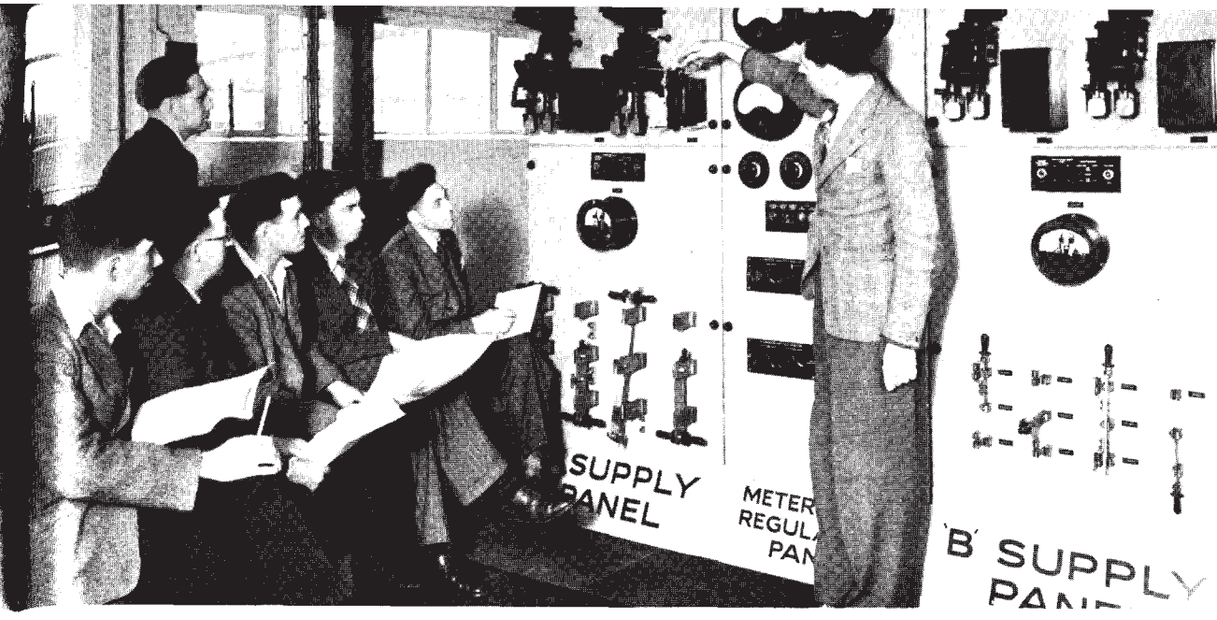
The Bournemouth Telephone Area comprises 1,056 square miles, mainly in the County of Dorset, although the most densely telephoned part is around Bournemouth, which is in Hampshire. There are 70 exchanges, 22 manual and 48 auto, 70,300 stations, 43,300 exchange connections, and a total staff of all grades of 950. Almost all the largest exchanges are still manual. The annual revenue is now about £1,000,000.

The Area has a beautiful coast line and hinterland and its boundaries closely coincide with the Wessex of Thomas Hardy. Its most important industries are holiday making (which keeps Telephone people very busy!) and agriculture, and there is also the important naval base of Portland—a huge rock which supplied the stone for St. Paul's Cathedral and other famous buildings. It is packed with relics of English history, ranging from the days of the earliest British inhabitants to the invasion of Europe in 1944. The first cross-channel cable to the Normandy Beach Head was terminated at Southbourne, in Poole Bay.

No report about the Area would be complete without mentioning the close ties with the Channel Islands, where a number of our Engineering staff maintain the trunk communications.

Left to right: W. H. GROVES, Senior Sales Superintendent; S. G. M. CAPLE, Chief Clerk; H. C. PINCH, Chief Traffic Superintendent; E. S. RUSBRIDGE, B.Sc.(Eng.), Area Engineer; W. R. TYSON, B.Sc. (Eng.), M.I.E.E., Telephone Manager.





Demonstration on a power switchboard

The Central Training School of the Post Office Engineering Department

by H. R. Harbottle,
Training Branch, Engineering Department

WITH THE RAPID EXTENSION OF AUTOMATIC telephony in this country from 1926 onwards, it was soon evident that engineering staff must be carefully trained in the maintenance and installation of the equipment. Most of the comparatively few experts in this development at that time were located in London, and a central training school was therefore established in King Edward Building, E.C. The success which attended this new phase of the Engineering Department's activities and the increasing use of thermionic valve repeaters for long-distance trunk circuits resulted in an expansion of the school for training staff engaged on the maintenance of transmission equipment.

Continued increase in the demand for training necessitated larger premises, and these were built and occupied in 1931 at the Post Office Engineering Research Station, Dollis Hill, N.W.2.

At the outbreak of war in 1939, centralised training was suspended temporarily, but it was soon started again at Cambridge. The automatic school was subsequently dispersed to Otley, Yorkshire, and Birmingham. Part of the transmission school was transferred to Wood Street, London, at a later date.

After the war, the Engineering Department's centralised training was regrouped at Yarnfield, near Stone, in Staffordshire. This site was selected from many visited, because temporary, single-storey wartime hostel buildings were available there and were suitable for conversion to meet the requirements of the school. The hostels were built originally to house staff employed at the Royal Ordnance Factory, Swynnerton, but, in fact, three —Duncan, Howard and Beatty Halls—had been occupied by United States Air Force personnel.

Each of the three hostels occupies about 15 acres, Duncan and Beatty Halls being about a quarter of a mile in opposite directions from Howard.

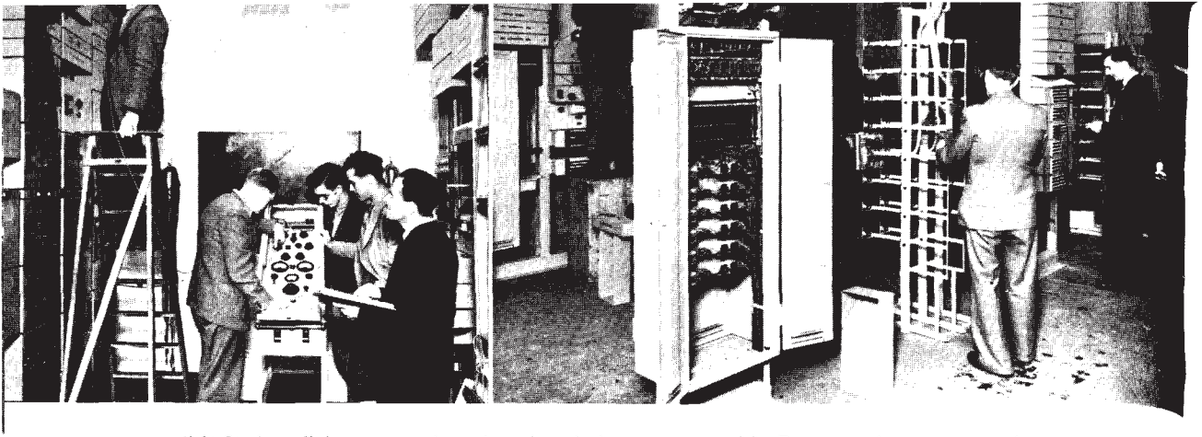
Following the recommendation of the Post Office Training Committee, the school is residential and, because of housing difficulties, official living accommodation is provided for single and married school staff. Duncan Hall is the school proper; Howard Hall retains its original function as a hostel for students and unmarried school staff; Beatty Hall has been converted into 89 two- or three-bedroomed bungalows for married school staff. The latter provision soon proved inadequate, and an additional 61 bungalows have recently been made available by converting hostel buildings at Raleigh Hall, which is some four miles from the school.

To reduce the cost of conversion, certain departures from an ideal layout had to be adopted. For instance, as some bays of the standard equipment required for demonstration are 10 feet 6 inches high, these were installed in those parts of the existing hostel buildings which had adequate headroom—for example, dining rooms and kitchen—irrespective of the location relative to lecture and practical rooms.

The school has three main functional divisions, Automatic Telephony, Transmission and Miscellaneous, but the general scheme of training in each is the same, namely a basic course followed by more specialised courses. More than 100 different courses, varying in length from two to seven weeks, are available, and these cover a wide range of subjects for a variety of staff, from a Youth's course in Radio to a course in Management for Area Engineers. As over 7,000 students attend the school annually for an average period of four weeks, the normal student population is approximately 600.

The maximum number of students on any one course is limited to 24. Generally the lecturer, an Assistant Engineer, in charge of a full course, is assisted by three demonstrators, who are Technical Officers. Hence, during a demonstration, it is possible for the demonstrator to give individual attention to the eight students in his group, and none has difficulty in observing any part of the demonstration.

Before a student comes to the Central Training School for a course, attempts are made to ensure that he has had at least two months' "field" experience, so that he will not be unfamiliar with his subject. In some instances a satisfactory report of his performance at a preparatory Regional School course or, alternatively, some other recognised technical achievement, is required before he is accepted. Furthermore, it is considered essential



(left) Students lining-up a 12-channel carrier telephone system *(right)* Demonstration repeater stations

that, for at least three months after leaving a Central School course, a student should be employed on duties which will enable him to consolidate the training given. Thus, the Central Training School course can be regarded only as a part, but a vital part, of the training required for particular engineering duties.

As an example, before a student attends for a Basic Automatic course, he should spend at least two months in an automatic exchange, so that he becomes familiar with the equipment and its general layout and function. On return to his Area, after the school course, he should continue his "field" experience in the exchange and undertake appropriate testing and adjustments of the equipment, at first under supervision and, when competent, unaided. While such a student is at the Central Training School, he receives instruction in tracing the operation of automatic exchange equipment from circuit diagrams and in identifying the actual components in correct sequence on demonstration equipment. Faults are introduced to give him practice in location and clearance. Practical experience in adjustments is also obtained.

It will be realised that the conditions under which this is done at the school are vastly superior to those existing in the field. This is one obvious reason for requiring the "field consolidation" after a school course.

The more specialised Automatic School courses relate to non-director, director and unit automatic exchanges.

For many years, engineering training was directed almost entirely towards what might be described as the inanimate side of the work—that is, the purpose, construction, operation and performance of the various types of equipment used by the Department, but more recently greater study has been given to developing the most effective utilisation of the manpower available, in an endeavour to increase the output per individual. Hence, when supervising officers attend the courses in Organisation and Supervision, which have been held at the Central Training School for the past two years, they are encouraged to think about their job and how to get the best work from the staff under their control. The subject of management is not an exact science, and so the nature and conduct of these courses are very different from others. Broadly, the students teach themselves by means of guided discussions and role playing and by solving live "cases".

Other Courses

In addition to the Basic course in the Transmission School, courses are held for staff who will be required to maintain teleprinters and other telegraph apparatus or who are to be employed in amplifier stations or repeater stations, which may contain audio, carrier, coaxial and, perhaps, voice frequency telegraph equipment, or who may be concerned with circuit provision and other aspects of line transmission.

The Miscellaneous School is responsible for training in a variety of subjects. These comprise Power—from simple office wiring to lifts and automatically-operated prime movers driving generating plant for exchanges and repeater stations—Radio and Television (including interference suppression), Local Line Planning, Teaching Methods and Management.

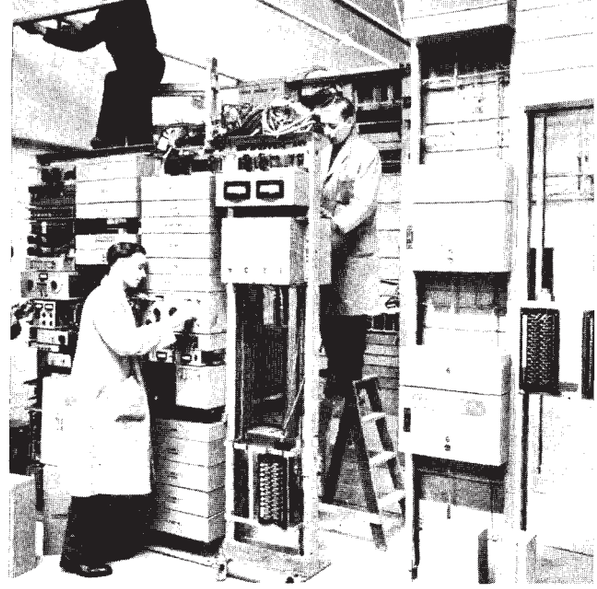
To facilitate instruction and demonstration, the audio, carrier and coaxial equipment necessary for complete systems is housed under one roof, although each terminal and the intermediate repeaters may be in separate rooms.

To complete this brief survey, a short description of the hostel arrangements and welfare facilities for students follows. Two students are allocated to a bedroom, which contains two single beds, two dressing tables, two wardrobes, table and chairs. Each hostel sleeping block at Howard Hall has 96 such bedrooms and communal lounges and lavatories. There are two similar dining rooms for students, each seating about 200, so there must be more than one sitting in each dining room for the main meals.

The theatre at Howard Hall is renowned throughout the district for the high standard of its cinema and stage shows. Dances are held twice weekly and the floor area is sufficient for two badminton courts. The theatre is also used for the reception of students when starting their courses.

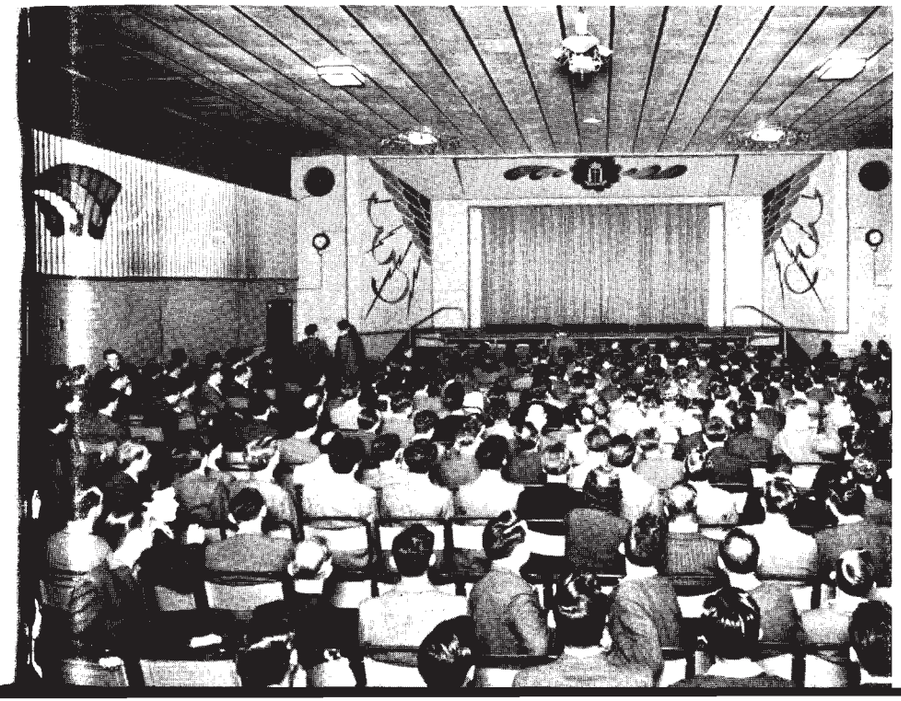
Students can enjoy indoor and outdoor games and sports. The students' billiard room is a popular feature. It is well equipped and, in spite of heavy use, the maintenance is very good.

As regards outdoor sports, the Central Training School Sports and Social Club has developed a nine-acre field between Howard and Beatty Halls for cricket, hockey and Association football. Six hard tennis courts have also been provided. The Civil Service Sports Council has given valuable advice and assistance, but the success achieved so far has been due largely to the voluntary efforts of the school staff.



Co-axial repeater equipment

A well-equipped sick bay under the care of a matron, assisted by two nurses, is available for students and staff. A local doctor attends twice weekly. During 1950–51, there were 865 in-patients, and 6,640 out-patients received treatment.

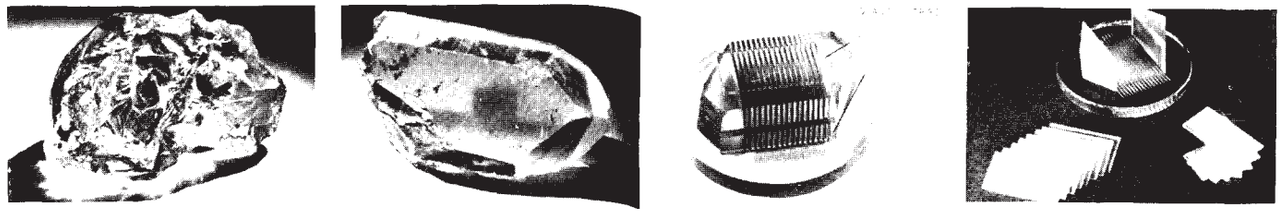


School Theatre, Howard Hall

Piezo-Electric Crystals

by J. E. Thwaites, A.M.I.E.E. Engineer-in-Chief's Office

Crystal being set in machine ready for cutting into slabs



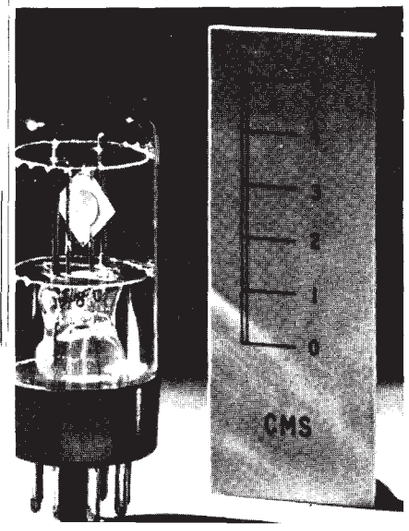
left to right Irregular and well-faceted natural quartz crystals—quartz slab sliced into plates—Plates removed from slab and cleaned

Testing orientation of cut surface of crystal with X-ray spectrometer

CRYSTALS WHICH DEVELOP AN ELECTRIC charge when squeezed or stretched, or which become mechanically stressed when an electric charge is applied to them are called "piezo-electric" (from Greek *piezein*, to press). They are not to be confused with the rectifying crystals used in "catswhisker" detectors.

The piezo-electric phenomenon was discovered by the Curies in 1880, but has been applied to telecommunications only within the last twenty-five years or so. Piezo-electricity is a property of many crystals, some being minerals and some being capable of manufacture from solution. Chief among the mineral varieties is quartz. Of the synthetic water-soluble crystals, ethylene diamine tartrate (EDT) and dipotassium tartrate (DKT) have received much attention and are probably the most useful for telecommunications. No satisfactory substitute has yet been found for quartz when great precision and constancy are required.

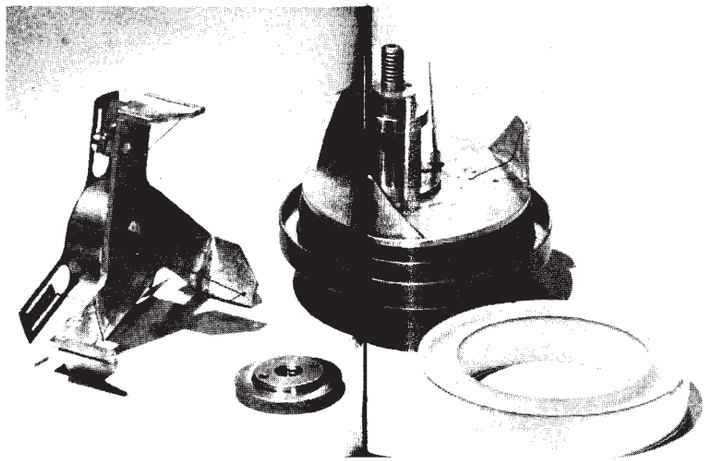
Typical mounted unit for radio transmitter frequency control



The phenomenon is utilised in the crystal oscillator by placing a plate or rod of piezo-electric crystal between electrodes and connecting these to a thermionic valve in such a way that the valve and its batteries supply sufficient energy to keep the crystal vibrating and the frequency of vibration is primarily determined by the crystal itself. Such an arrangement is widely used for generating the carrier wave of a radio transmitter. Another use for crystals in telecommunications is as resonators in the numerous filters required in multi-channel telephone systems. Here they remain passive until excited by the particular frequencies for which they were designed and thus are able to filter out or separate one band of frequencies from others.

In the manufacture of such vibrators, the natural crystal is first carefully examined for flaws such as internal cracks and is then cut in the appropriate direction, with a metal disc charged at its edge with powdered diamond, to form slabs. These slabs are then cut into slices of about the right size and shape required and the slices are ground or lapped precisely to specified dimensions. In the lapping machine shown, plates of quartz are located in holes in a thin diaphragm resting on a cast-iron plate or lap and another similar iron lap is placed upon them. The diaphragm and the quartz plates are driven round between the laps by the crank, a mixture of liquid and abrasive powder such as carborundum or emery is applied at intervals through the holes in the top lap and the process is continued until the crystal plates are worn down to the desired thickness.

100 kc/s. quartz ring used for frequency standards and quartz clocks



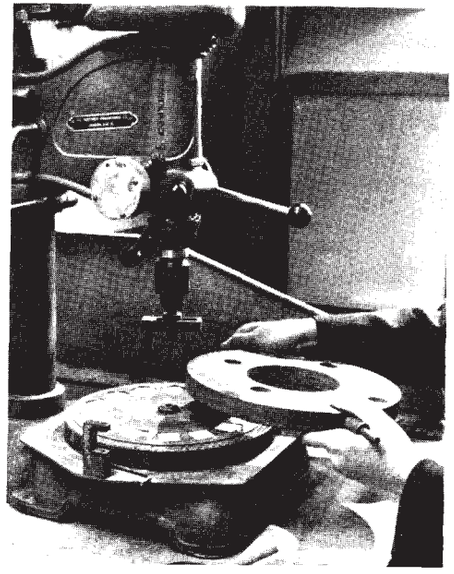
The edges of the plates are trimmed to size and the plates then receive coatings of gold, silver or aluminium, which form the electrodes. Their vibration frequencies are measured and small adjustments of dimensions are made until the correct frequency is obtained from each unit. Finally each plate is mounted in a container, usually of the glass valve type, which is evacuated and sealed.

The frequency of vibration of a crystal plate or rod depends not only upon its dimensions, but also upon its mode of vibration—flexural, extensional or shear. Quartz flexural vibrators a few centimetres long may have frequencies as low as 1,000 cycles per second, whereas small plates a few hundredths of a millimetre thick can be made to vibrate in "thickness-shear" one hundred million times a second.

The most important effect of the cutting direction is its influence on the stability of the product when subjected to temperature change. Modern requirements are so stringent in this respect that it is necessary, in some cases, to make the cutting angle correct to within two or three minutes. For this reason, an X-ray spectrometer is generally used to check the correctness of a cut surface by reference to the atomic lattice structure of the crystal.

Quartz vibrators, when carefully prepared and maintained, constitute perhaps the most accurate and constant standards of frequency and provide the most accurate time-keeping instruments known. Quartz clocks controlled by ring units of the type shown here can have a rate predictable to 1 100th second per month. (Readers will remember the article on "Quartz Crystal Clocks" in this Journal in February, 1951.)

The photograph of cleaned plates (above, centre) appears by courtesy of the "Post Office Electrical Engineers' Journal".



The drill press lap

Ceremony in 1927

25th Anniversary of the Opening of the Trans-Atlantic Telephone Service

TELECOMMUNICATIONS, WITH THEIR ability to shrink the world to small proportions, have become such a part of our daily life that from time to time we tend to forget just how young some of the greatest achievements are.

The 7th January of this year marked the twenty-fifth anniversary of the first trans-Atlantic telephone conversation. On that day messages were exchanged between Lord Salisbury and Sir Alexander Little, Director-General of the Post Office, in London, and Mr. Walter S. Gifford, American Ambassador to the Court of St. James's, who was visiting Washington, and Mr. Craig, President of the American Telegraph and Telephone Company, in New York.

The occasion was the more interesting because Mr. Gifford had taken part in the inauguration of the Trans-Atlantic Telephone Service. As President of the American Telegraph and Telephone Company, he made the first call, in 1927, to Sir Evelyn Murray, Secretary to the General Post Office, in London.

Mr. Gifford repeated on this occasion a sentence which he had used in 1927, and its aptness is even greater now than perhaps he realised at the time of that first call. It was:

"*Through the spoken word, the people of New York and the people of London will become neighbours in a real sense, although separated by thousands of miles.*"

LONDON: Lord Salisbury *(left)* and Sir Alexander Little

NEW YORK: Mr. Craig

WASHINGTON: Mr Gifford

(Photo. of Mr. Gifford by Buckingham Studio, Inc., Washington, D.C.)

The First Printing Telegraph

by G. R. M. Garratt, M.A., M.I.E.E.

Deputy Keeper, Science Museum, London

WE ARE SO ACCUSTOMED TODAY TO THE almost universal use of the teleprinter in the practice of telegraphy that we sometimes forget that the printing telegraph is almost as old as the electric telegraph itself. An interesting reminder of this has been given recently by the discovery at King's College, London, of the first two printing telegraphs ever made—by Charles Wheatstone, in 1841.

As may be remembered, the introduction of the electric telegraph as a practical means of communication was due principally to the work of W. A. Cooke and Charles Wheatstone from 1837 onwards. Cooke, a practical man who had been compelled for reasons of health to resign from the army in India, was not a scientist, but he realised the potential value of electricity as a means of signalling. Early in 1837, he had devised a telegraph instrument but, meeting certain difficulties, he was led to consult Wheatstone, who was then Professor of Experimental Philosophy at King's College. This meeting led to a partnership and to the granting of their first patent for an electric telegraph on the 12th June, 1837.

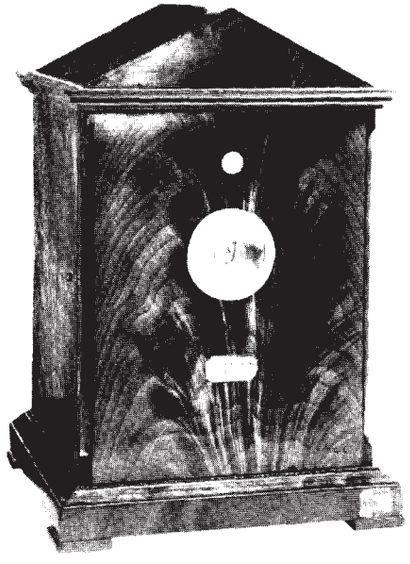
Cooke at once began to develop and exploit the invention commercially, and the new railways then beginning to spread over the country provided a splendid opportunity. Early in 1839, the Great Western Railway was about to open its new line from Paddington to Slough and, as a first step, it was decided to install the electric telegraph on this line between Paddington and West Drayton. It was successfully completed in May, 1838, and later extended to Slough.

The instruments used on this and many other lines that followed were of the needle type, a form of instrument favoured by Cooke for practical signalling. His partner, Wheatstone, was less interested in the immediate practical applications, however, and favoured a form of instrument in which the letters to be signalled could be transmitted and read directly as ordinary letters by unskilled persons. He considered any form of code undesirable, and this led him to develop his step-by-step or "A.B.C." form of telegraph early in 1840. This instrument was very slow in operation, but in an improved form it was later to find wide use on private circuits.

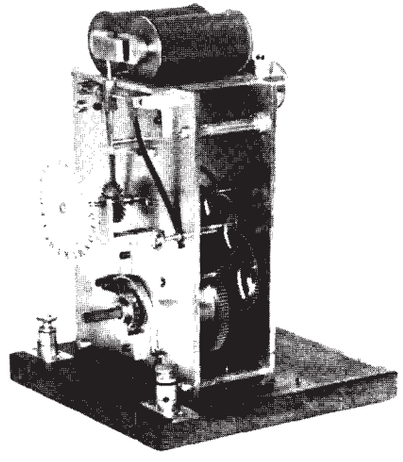
While it seemed to Wheatstone that a telegraph in which the letters were directly indicated was better than one in which some form of code had to be employed, it seemed obvious that an even more desirable step would be one in which the message was actually printed by the receiving instrument. Leaving Cooke to develop the telegraph commercially, Wheatstone therefore proceeded to develop his step-by-step instrument as the basis of a printing telegraph in 1841.

It had been known for many years that Wheatstone had invented a printing telegraph in 1841; it is mentioned in the 1860 edition of the *Encyclopaedia Britannica* and it was covered in Wheatstone's Patent No. 9.022 of 1841; but with the exception of these and two or three other isolated references, all record of the instrument seemed to have vanished. There was no positive certainty that the invention ever became anything other than an idea or that a working instrument had ever been constructed. Hence, Wheatstone has never been regarded as a pioneer of the printing telegraph.

A few months ago, I was invited to make a survey of a considerable number of instruments in one

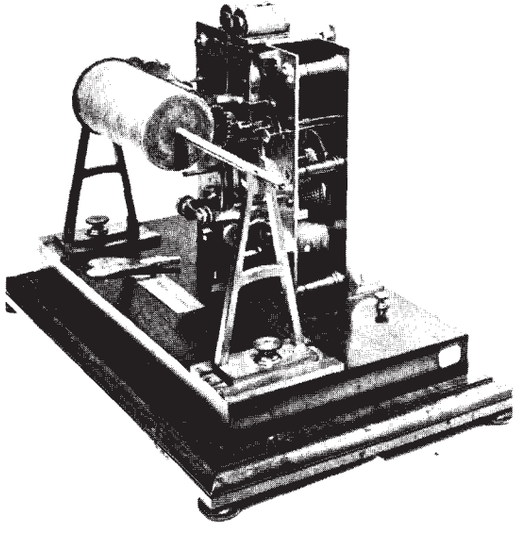


Wheatstone's A.B.C. or Step-by-Step Telegraph of 1840.

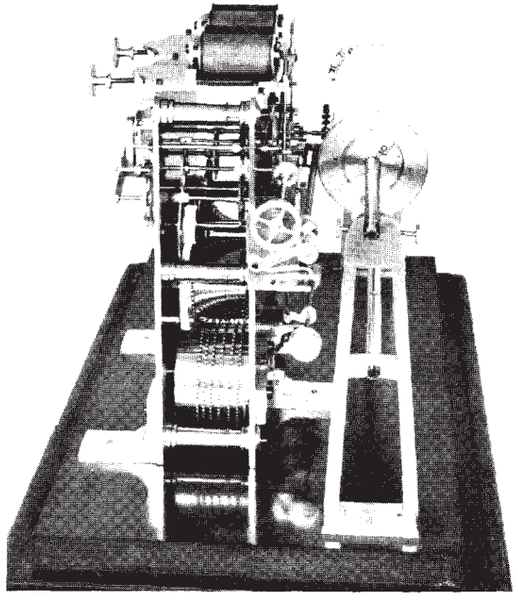


WHEATSTONE'S PRINTING TELEGRAPH OF 1841

This instrument, probably the earlier of the two made by Wheatstone in 1841, is now in the Royal Scottish Museum, Edinburgh.



This later version of the printing telegraph, which is still in perfect working order, is now in the Science Museum, London.



of the laboratories at King's College, London. Many of them were connected with Wheatstone and dated from about 1830–1850, and many related to the early days of the electric telegraph and to other scientific fields in which Wheatstone worked.

Among the collection were two instruments which were obviously designed for printing a message. They were in such an excellent state of preservation that it seemed unlikely that they were made over 100 years ago and, as I was certainly not anticipating the discovery of the original printing telegraph instruments, I did not at once appreciate the significance of these two. Even the fact that one of them was labelled "Patented in 1841" did not "make the penny drop".

It was not until some days later that the probable importance of the instruments occurred to me, and some weeks elapsed before I was able to establish beyond doubt that these two instruments were in fact the first two printing telegraphs ever devised. Careful comparison with the patent drawings, however, with contemporary step-by-step instruments and with the known history of the instruments in the laboratory of King's College left no doubt whatever that these were the original instruments devised by Wheatstone in 1841. A contemporary description appeared in the *Year Book of General Information for* 1843.

The two instruments are similar in principle but differ quite substantially in detail, and it is safe to assume that they represent the first and second stages in development. One of the instruments—it is almost certainly the earlier of the two—has now been lent to the Royal Scottish Museum at Edinburgh; the other is now on exhibition at the Science Museum, London.

In their basic principle, the instruments are very similar to Wheatstone's A.B.C. or step-by-step telegraphs of 1839–40. In these instruments, the letters of the alphabet were printed round the edge of a small disc of cardboard mounted on the escapement shaft of a clockwork mechanism. The escapement, controlled by an electro-magnet, was arranged so as to allow the disc to rotate letter by letter, in single steps, in response to impulses from the electro-magnet. The disc was divided into twenty-four divisions (23 letters and a ·–·) and thus it follows that although only one impulse had to be sent to signal the letter *B* if the preceding letter had been an *A*, no less than 23 impulses had to be sent to indicate an *A* if the previous letter had been a *B*. In consequence, signalling was slow, a maximum of only five words per minute being attainable.

In Wheatstone's two printing telegraphs, the cardboard disc was replaced by a similar disc of thin brass, slotted from the circumference almost to the centre so as to form twenty-four flat springs, upon the ends of which were fixed a set of type characters. The disc was rotated in exactly the same manner as in the simple A.B.C. telegraph, but an additional mechanism was provided for causing a hammer to strike each selected letter against a cylinder, around which was wrapped alternate sheets of white and carbon paper.

The mechanism that operates the hammer is complicated and is arranged also to rotate and traverse the cylinder after the printing of each successive letter. There are substantial differences in the details of this mechanism as between the "Edinburgh" example and that in the Science Museum, although the final operation of the hammer is similar in both cases.

The instrument in the Science Museum has been thoroughly cleaned in the Museum workshops and two broken springs replaced. With these two replacements and several minor adjustments, the instrument was found to be in perfect working order.

These instruments were never used commercially. In 1841, electric telegraphs of any form were novelties, the real need for which was scarcely appreciated. The world was certainly not ready for a printing telegraph, especially as its rate of working was still no higher than two words per minute. Nevertheless, these two instruments are of much historic value and their discovery after all these years in such a perfect state of preservation will be of interest to all communication engineers.

(The photographs accompanying this article are reproduced by courtesy of the Science Museum, London, S.W.7.—Editor)

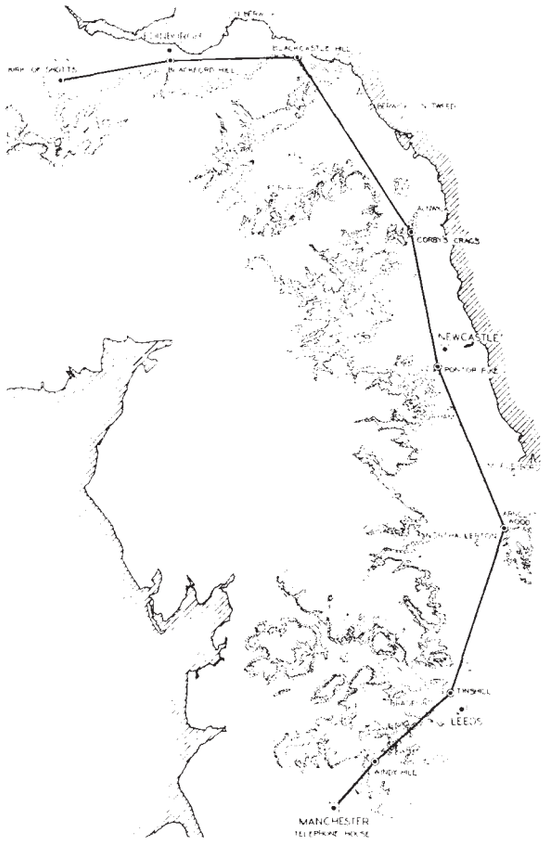
Manchester-Kirk o' Shotts Television Radio Relay System

WHEN THE POST OFFICE WAS ASKED TO provide a connection between Manchester and the projected Scottish television broadcast transmitting station between Glasgow and Edinburgh, it was decided that this should be by radio relay, as no cable route could be made readily available. The contract was placed with Standard Telephones and Cables, in June, 1950.

The route is 250 miles long and the television signals are relayed between Manchester and Kirk o' Shotts by seven intermediate repeater stations. The receiving and transmitting aerials at each station have to be "in sight" of the aerials of the stations on both sides of it, as the very-high-frequency radio waves used are transmitted efficiently only over optical paths. This means that the stations are on hill-tops and often in inaccessible positions. The longest hop is 46 miles.

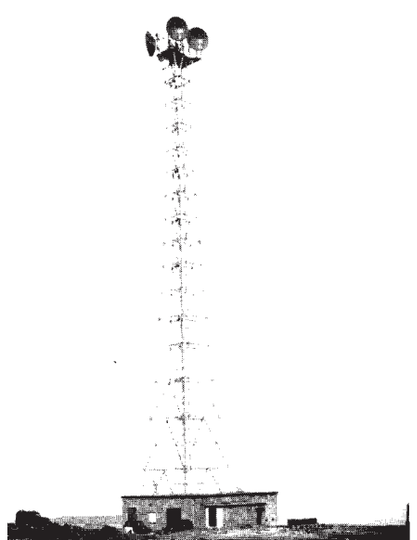
The radio frequencies used are around 4,000 megacycles per second and about four times those used for the London-Birmingham radio relay system. The wavelength is about 3 inches. Use of these very high frequencies allows much less power to be used.

The frequencies used are beyond the limits of ordinary valves, however, and use is being made of a new kind of valve known as a travelling wave amplifier, which was invented by a physicist working in the Clarendon Laboratory at Oxford University. This is the first large-scale commercial application of this amplifier anywhere in the world.



At each radio relay station, the equipment is housed in a small building at the foot of the mast carrying the receiving and transmitting aerials, to which it is connected by hollow tubes known as wave guides. This is the first service use of wave guides by the Post Office. The aerials are paraboloids, somewhat like searchlight reflectors.

When completed, the relay stations will have working and stand-by equipments, the latter being brought automatically into service on failure of a working equipment. They will also have stand-by petrol-driven generators, which will be started up automatically if the mains supply fails. There will be comprehensive remote-control and supervisory facilities provided over a telephone line interconnecting all stations. When all the stand-by and remote-control equipment has been provided, the relay stations will not normally be manned.



The station at Black Castle Hill

The Harbour Communications System at Liverpool*

by Captain W. R. Colbeck, R.N.R., Marine Surveyor, Mersey Docks and Harbour Board

A LARGE PORT REQUIRES AN EFFICIENT communications system, to enable full use to be made of all the berths and to avoid delay to incoming vessels. Although a vessel's agents usually give prior advice and make provisional berthing arrangements, last-minute alterations are frequently necessary; for instance, the previous vessel in the berth may not have completed loading or discharging, or the draught of the incoming vessel may be greater than was expected and diversion to another dock system become necessary.

The large tidal range at Liverpool, sometimes as much as 32 feet on spring tides, confines the docking of a deep-draught vessel to a short period around high water, and a delay of one hour in the delivery of instructions may mean a delay of at least twelve hours to the vessel. Lack of last-minute information as to whether a vessel will berth at the expected time may cause delay and uneconomic occupation of berths, through necessary dock labour not being arranged, or the vessel may be delayed by the absence of tugs. At the bigger dock entrances, the provision of direct communication between the Dock Master and the pilots is invaluable. With a number of ships manoeuvring in the river preparing to dock, the Dock Master is able to tell each vessel exactly what is happening with regard to outward traffic and in what order he proposes to dock the incoming vessels, thus saving dangerous congestion at the dock entrance and reducing the risk of collisions. Furthermore, a large fleet of vessels, including dredgers and buoyage and salvage vessels, is operated by the port authority and the facility for the rapid transmission of orders will assist in keeping them fully employed.

The communications system has grown up over a long period, as requirements increased and improved methods of communication were developed.

* This article is based on a paper read by the author before the Post Office Telegraph and Telephone Society.—*Editor.*

The early history of the Port of Liverpool is somewhat obscure, but in August, 1207, King John granted letters patent to the town, and by the middle of the 17th century shipping was the principal industry. The great port of today, with its system of docks on both sides of the river, was initiated in 1715, when the first enclosed dock, with gates to impound the water, enabling vessels to remain afloat throughout the tidal period, was opened. The total water area of the docks today exceeds 650 acres, the length of the quays being $37\frac{3}{4}$ miles, exclusive of the twelve dry docks for ship repairing.

Until 1857, the docks were owned by the Corporation of Liverpool, who also administered the local lighthouses and buoyage.

Dock Board

The Mersey Docks and Harbour Board, constituted by Act of Parliament in that year to take over the entire control of the port accommodation, is a body of twenty-eight members, twenty-four of whom are elected by the dock ratepayers, i.e. shipowners or merchants paying dues on ships and goods; the remaining four are appointed by the Minister of Transport. The Dock Board is also responsible for the administration of the pilot service.

The River Mersey is the highway to the Port of Manchester and the docks at Garston and Bromborough, as well as to the Liverpool and Birkenhead docks.

During the 12 months ending 1st July, 1951, 16,072 vessels of 21,156,984 gross tons entered the river, 9,180 vessels of 15,508,911 gross tons entering the Board's docks. The average number of vessels entering the river is therefore 44 per day. These figures relate to entries only and a similar number of vessels leaves the river each day.

The Dock Board is the conservancy authority for the river and the estuary, and all vessels entering

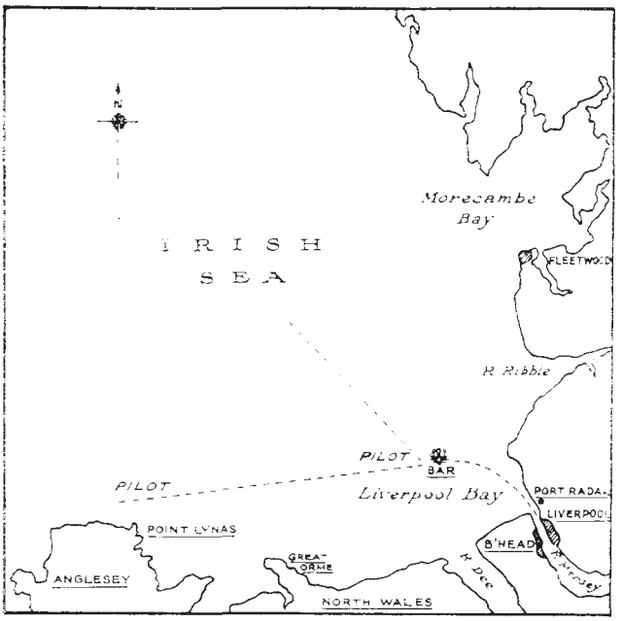


Fig. 1 Pilot stations and inward routes to Liverpool

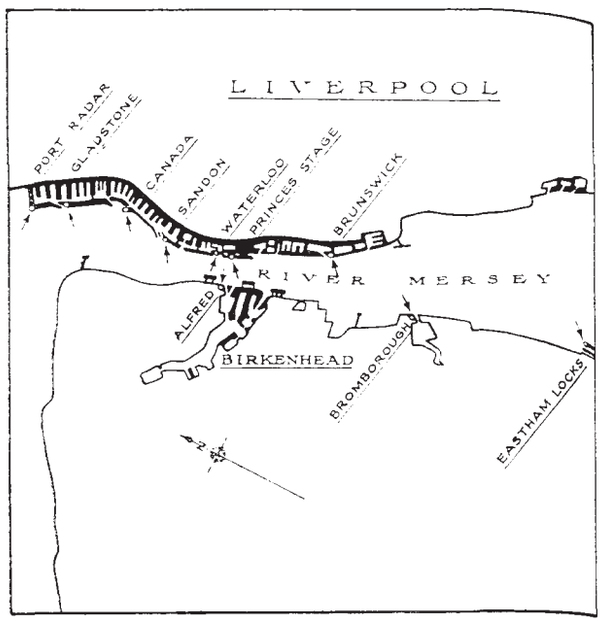


Fig. 2. Positions of dock stations

the river, whether bound for the Board's docks or docks operated by other authorities, pay harbour rates to the Conservancy Fund. This money is used for the maintenance and improvement of navigation, including the buoying and lighting of channels and approaches, dredging and the construction of training walls, removal of obstructions etc. The cost of the communications system and the Radar Station is provided from this fund.

The rapid growth of commerce in the latter part of the 18th century and the increasing number and size of ships using the Mersey, required the provision of improved navigational aids, and in 1763 the Corporation embarked on a programme of lighthouse building on the shores of Liverpool Bay.

In 1771, the Bidston Lighthouse was erected on Bidston Hill, which is 200 feet above sea level and about $1\frac{3}{4}$ miles inshore from the north coast of the Wirral Peninsula. The lighthouse commands a view of the whole of the estuary of the Mersey and it was shortly after the building of this lighthouse that the first ship-reporting system was begun. Masts were erected alongside the premises and by a system of code flags etc. particulars of any vessel observed by the keepers could be reported, the signals providing for the type of vessel, her rig, whether British or foreign, and her position in the sea channels. These signals could readily be seen from the waterfront at Liverpool and later arrangements were made for local shipowners to be advised, when one of their vessels was in the offing, by the hoisting of a flag on the appropriate mast, some twenty additional masts being erected for the purpose. Provision was also made for reporting vessels in distress.

The outer boarding station for pilots is off Point Lynas, on the north coast of Anglesey (Fig. 1), where the Corporation erected a lighthouse in 1781, Lynas being 46 miles from the entrance to the River Mersey.

In 1827, the Dock Trustees established a visual semaphore system starting at the South Stack, an island off the coast near Holyhead, with a series of repeating stations, including Point Lynas Lighthouse, through to Bidston Hill. An office was established in Liverpool, from which the Bidston signals were observed and the names and positions of vessels were shown on a board at this office as the reports were received. The stations were situated some eight miles apart and in addition to forwarding information from the outer stations a look-out was maintained and the stations also initiated reports of vessels in their vicinity, the stations being manned throughout the hours of daylight. The reporting of the positions of vessels was by the same system that is used today by the B.B.C. in its running commentaries on sports events, a gridded chart being supplied to each station and the vessel reported as being in "square so-and-so", one-mile squares being used inshore of the Bar Lightvessel and five-mile squares from the Bar to South Stack.

In 1860, after a number of experiments, an electric landline telegraph was installed linking all the existing stations and terminating at the office in Liverpool. In 1870, this line was taken over by the Post Office and, although all the intermediate stations have been dispensed with, it is still the means of direct communication between Point Lynas and the Port Radar Station, the South Stack station being closed in 1918.

Following the recommendations of the Royal Commission on Electrical Communication with Lighthouses and Lightvessels, in 1895, the Formby Lightvessel was connected with Crosby Lighthouse by telephone, and telephones were installed between various other lighthouses and lifeboat stations at the expense of the Government, the Board having the right to use them for operational traffic.

Although the Board's officers had been interested in wireless telegraphy from 1901 and had co-operated in several experiments, it was not until 1913 that a wireless telegraph shore station was established to communicate with the Bar Lightvessel, the Formby Lightvessel being fitted the following year. In 1921, the wireless telegraph was replaced by radio-telephony, the other lightvessels and the Marine Department buoyage and salvage vessels being fitted in subsequent years. This system was fitted primarily for reporting casualties to shipping, but was also used for the reporting of inward vessels and for operational traffic of the Board.

The pilot boats were equipped with radio-telephony in 1936, but they do not operate on the Board's frequency, all traffic, which is mainly in respect of the supply of pilots, passing through the G.P.O. coast station at Seaforth.

During World War II, serious congestion and delays to shipping were experienced, due to the simultaneous arrival of large numbers of ships in convoy, as many as 70 vessels arriving in one convoy. Owing to the tidal regime of the river, as already mentioned, the docking of large vessels is restricted to a comparatively short period around high water, although at the new entrances small and medium-sized vessels can dock at any time. Such a large number of vessels could not all be handled on one tide; the order of arrival was not known in advance, nor could it be known which vessels might be missing from the convoy, and the transmission of docking instructions by wireless telegraphy or medium-frequency radio-telephony was not permissible for security reasons.

With the assistance of the army authorities, a short-range high-frequency radio-telephone system was adopted, using army type 18 and 38 equipments operating in the 7 to 9 megacycle band. Six shore stations were established at various dock entrances, with Gladstone as the main station, the pilots taking "walkie-talkie" sets with them when they boarded inward vessels. This communication system proved so valuable to the Port Authority that it was decided to continue its use after the end of the war.

In 1946, the G.P.O. was approached and a provisional allocation of frequencies in the 84–86 megacycle band obtained. Several manufacturers were asked to tender for the equipment and prototype sets tested, but in 1948, following international agreement, the frequencies were altered to the 150–170 megacycle band, requiring a considerable amount of development work by the manufacturers before a satisfactory equipment could be produced. The opening of the Port Radar Station (Fig. 2) in July, 1948, produced an additional demand for rapid and efficient communication. Owing to a further alteration in the frequency allocation in September, 1949, to meet international agreements, requiring a considerable degree of modification to the equipments being produced, it was not until April, 1950, that the new system of very high frequency radio-telephone communication could be brought into operation.

Organisation and Operation

The V.H.F. radio-telephone communication system uses two-frequency simplex, amplitude-modulated, six radio-frequency channels being allocated, spaced 100 kc. s. apart, the go and return frequencies being separated by 4.5 Mc. s. The land transmission frequencies are in the band 163.10 Mc. s. to 163.60 Mc. s, the mobile transmission frequencies being in the band 158.60 Mc. s. to 159.10 Mc. s. Although duplex operation would have been preferred, the power drain of the receiver and transmitter working simultaneously would have necessitated larger batteries in the portable equipments, increasing the weight above that which could be tolerated.

The six channels are allocated as follows:

1—Port Radar Station; 2—Port Radar Station and Bromborough; 3—Gladstone and Waterloo;

4—Prince's Stage and Canada; 5—Sandon and Brunswick; 6—Alfred and Eastham.

The M.F. radio-telephone operating on a frequency of 1,852 kc. s. is used only for operational communication with the Bar Lightvessel and with the salvage and buoyage vessels, whose duties frequently take them far beyond the range of the V.H.F. equipments.

The main communication centre is the Port Radar Station, situated at the north-west corner of Gladstone Dock at the mouth of the River Mersey. From this position a clear "line of sight" for both radar and V.H.F. aerials is obtained over the whole of Liverpool Bay and the greater part of the river where it is navigable by large vessels.

The communications room is adjacent to the room housing the radar console, the equipment comprising:

1. V.H.F. R/T. Channel 1.
2. V.H.F. R/T. Channel 2.
3. M.F. R/T.
4. Teleprinter to Marine Department Head Office.
5. Telephone direct to Marine Department Head Office.
6. Telephone direct to G.P.O. Telegrams.
7. Two telephones to Board's P.A.B.X.
8. Telephone to G.P.O., Bootle Exchange.
9. Morse telegraph instrument on private wire to Point Lynas.

Both V.H.F. channels and one line to the private branch exchange have extensions to the radar console.

The station is manned continuously by two men, one radar operator and one telegraphist telephonist, the number being increased, if necessary, during prolonged periods of fog. The men are trained to be able to carry out both duties if required.

The traffic handled by the communications staff comprises docking and berthing instructions for vessels; weather and visibility information from lighthouses, lightvessels, coastguards etc. in Liverpool Bay and the river; operational messages concerning buoyage, dredging and assisting shipping casualties; distribution of navigational warnings concerning casualties to sea marks, shoal soundings etc. and the transmission of information derived from the radar screens to aid vessels navigating the channels.

The dock stations are situated in the Dock Masters' offices at the respective dock entrances, where the staff is always on duty. The message traffic handled is confined to docking instructions: for instance, where more than one vessel is waiting to enter a particular dock, the Dock Master decides in which order they will enter and the times of entering, having regard also to the outward traffic. Communication between the various dock entrances and the Port Radar Station is by landline telephone through the private branch exchange for the Board's docks, and via the G.P.O. exchanges for Eastham and Bromborough.

Advance information of the expected arrival of vessels is received from the agents and provisional berth allocations are made by the Harbour Master. These advices are usually based on wireless telegraph messages received by the agent through the G.P.O. coast stations.

Pilotage

Pilotage is compulsory and the majority of inward vessels take their pilots aboard off Point Lynas. A second pilot boat cruises off the Bar Lightvessel, about 14 miles from the entrance to the river, for inward vessels approaching the port from the north and to take the pilots from outward-bound vessels. The pilot takes on board with him a portable V.H.F. set, and when approaching the Bar Lightvessel, at a range of about 23–24 miles from the Port Radar Station, he calls the station, giving his position, draught of water and expected time of arrival in the river. This information is passed to the Harbour Master, who confirms or, if necessary, amends the provisional docking instructions, and the necessary orders are passed to the vessel. At the same time the pilot can obtain information about weather and visibility conditions etc. If he does not require navigational aid from radar, he then closes down until the vessel enters the river, when he calls the Dock Master of the entrance for which he is bound on the appropriate frequency, to obtain permission to dock.

It must be pointed out that that system is used by large vessels. Small vessels are exempt from compulsory pilotage and the masters of most of the small and medium-sized vessels coasting or on short voyages and regularly visiting the port have pilotage licences enabling them to pilot their own vessels and do not therefore have portable sets. To date, 22 such vessels, mainly employed on the cross-channel traffic with Ireland and the Isle of Man, have been fitted with permanent ship installations to communicate on the port frequencies, and further such installations are projected. Although some 20 vessels enter the river on each tide, fewer than half of them have portable V.H.F. sets on board. During the 12 months ending July,

1951, a total of 4,048 vessels received their docking instructions by V.H.F. radio-telephone.

Outward-bound vessels do not usually carry portable V.H.F. equipments, as berthing or tug arrangements are not required. They are supplied on request of the pilot, however, if he considers he will require radar assistance during his passage of the sea channels.

There are several other bodies using radio-telephone communication on individual frequencies within the limits of the port. Although they are not controlled by the Board, the services they provide are ancillary to the port services.

The Board does not operate tugs, all the towage services in the port being carried out by private companies. The four major tug companies have their own individual V.H.F. systems for communication between the tugs and their respective head offices, three operating on 67 Mc. s. single frequency and one on 160 Mc. s. Orders for tugs to assist in docking or at shipping casualties can thus be transmitted with little delay, the owners being aware at all times of what tugs are available and where they are situated.

The Liverpool Fire Service operates a large fire boat, which also provides the transport for the Port Health Doctor, who has to examine inward-bound vessels and give them a clearance before they can enter dock. She operates on the Fire Brigade frequency of 81.7 Mc. s.

One of the oil companies has a system operating on 160.7 and 165.7 Mc./s. for the control of berthing of coastal and harbour oil tankers transporting oil and bunkering services.

The Wallasey and Birkenhead Ferries operate on 159.5 and 164.5 Mc. s., mainly for radar assistance during low visibility, from their own shore radar installation at Seacombe. This service has proved of great value and ferry delays due to fog have been very slight since it was introduced.

Radar

The operation of a shore radar station to assist in navigating vessels requires efficient two-way communication between the master or pilot of the vessel and the operator at the radar console, and this has been achieved with the present equipment.

The radar installation, with its six display units, provides a series of large-scale pictures of the sea channels and the river and enables a vessel to be supplied with minute-by-minute information about her position and the course she is making good and the positions of other vessels in her vicinity. For many reasons, the control of a vessel must remain in the hands of the master and the pilot, and the information from the station is provided as an aid to navigation and is not a control, no direct orders being given about speed or the course to be steered. Details of position are usually given in the form of a running commentary from the station, its reception by the ship being acknowledged every five minutes. Vessels have entered with radar assistance from positions as far as eight miles seaward of the Bar Lightvessel, the passage occupying over two hours, continuous positional information being supplied to the vessel during the whole of this period.

Five vessels have been assisted at the same time, one operator using Channel 1 to distant vessels and a second operator using Channel 2 to vessels nearing the mouth of the river or in the river.

During the past 12 months, over 500 vessels have been assisted in this manner when entering the port during low visibility. The majority would have been delayed in the absence of such assistance, which could not have been provided without the V.H.F. communication system.

Equipment

The telephone and teleprinter installations at all stations are the usual G.P.O. equipment and require no special description.

The telegraph between the Port Radar Station and Point Lynas is a single-wire system using a deflection needle and a clockwork-driven Morse inker. Although this equipment is rather antiquated, it still functions very efficiently.

The M.F. radio-telephone sets are the Marconi "Sea Mew" at the Port Radar Station and the Ship Stations, with the exception of the Bar Lightvessel, which has a Type T.W.12. These operate only on the Board's frequency of 1,852 kc. s.

The V.H.F. radio-telephone installation, supplied by the Automatic Telephone and Electric Company, comprises ten shore stations, nine of which are situated at the dock entrances at Gladstone, Canada, Sandon, Waterloo, Prince's Stage, Brunswick, Alfred, Bromborough and Eastham, each operating on one channel, and the Port Radar Station operating on Channels 1 and 2, and 150 portable sets. The maximum number of portable sets in use at any one time never exceeds 15, the average being 11 ships a day. The establishment would appear at first sight to be somewhat ex-

cessive, but it is necessary, to enable efficient service to be provided. A relief boat visits the outer and inner pilot stations each day, taking a number of sets to keep the establishment on each station boat up to 30 sets.

When a vessel has docked, her portable set is collected by the dock staff and later the sets are transported by van once a day to the central depot at Prince's Stage. With the various delays, including week-ends, three or four days may elapse from the time the set is taken aboard with the pilot until it is returned to the depot. It is then checked for performance and, if found correct, the batteries are changed, the old ones being placed on charge, and it is then available for re-issue.

When large vessels are coming to Liverpool from, for instance, Glasgow or Belfast, the pilot frequently travels to the port of departure to join the vessel, taking with him a portable set. In these circumstances it may be a week or 10 days before this set is again available.

Fig. 3. Portable set in operation

Stocks of spare valves and other components are maintained at the central depot, which is equipped with all the necessary test instruments and battery charging facilities. The technician in charge is responsible for maintaining all the shore stations as well as the portable equipments and for the issue of the latter.

Design

Portable sets

The boarding stations at both Point Lynas and the Bar are in the open sea, and sets which have to be put on to a vessel with the pilot must be light, compact and very robust, as they have to be hauled up on a line from a small boat, which may be rising and falling six feet or more in bad weather. The following requirements were therefore specified:

1. The total weight of the set including batteries and aerial not to exceed 20 lb. ;
2. The transmitter-receiver, batteries and aerial to be contained in a padded canvas case with no projections, fitted with suitable slings for attaching a line for hoisting on board;
3. Batteries to provide a life of five hours' continuous use, 10 per cent. on transmission;
4. The sets to provide adequate two-way communication at a distance of not less than 23 sea miles from the Port Radar Station and 8 sea miles from the dock stations, when operated on the bridge of a medium-sized vessel; the second channel at the Port Radar Station to provide a range of 14 sea miles;
5. The sets to be capable of being submerged in sea water without serious damage and to float if dropped in the water;
6. No variable manual tuning to be necessary.

The portable set shown in Figs. 3 and 4 fulfils all these requirements and is simple to operate.

The set, with the exception of the accumulators, is contained in a hermetically-sealed metal alloy case fitted with a desiccator, the outer carrying case of waterproof canvas on a metal frame and padded with kapok, arranged so that it is necessary only to open the lid of the case and erect the aerial in order to operate the set (Fig. 3). The corners of the carrying case have rope protection, which continues to form two loops for attaching the hoisting line. Secured to the back of the case are two short lanyards, with which the set can be lashed to the bridge rail at a convenient height for operation, in a position where the aerial is clear of obstructions and has, as far as practicable, a clear line of sight to the shore station. Full operating instructions and a list of the various stations with their respective channel numbers and code calls are attached to the inside of the top of the carrying case, printed on linen so that they will not be damaged by water.

The aerial is of the sectional rod type, the lowest section being flexible, with a wire running through the sections. When folded up, it stows in the pocket in the front of the carrying case, with the handset. The length of the aerial is three quarters of a wavelength tuned at the mid-point of the transmission band.

The power supply is 4-volt, consisting of two standard 2-volt dry chargeable accumulators connected in series, carried in the second pocket in the front of the carrying case.

In the event of the set being submerged, only the batteries will be damaged.

The controls consist of a channel selection switch, operating switch and calling key. The channel selection switch is of the semi-rotary type with six positive positions for the six crystal-controlled frequencies.

The on off and transmit receive switch is combined, a rotary movement being employed, biased by a spring to the "off" position, thus automatically switching off the equipment when not in operation and preventing accidental running down of the batteries. A spring-loaded stop has to be passed when switching from "receive" to "transmit", enabling these positions to be selected in the dark.

A calling note of 1,000 c. s. is transmitted by operating a watertight push-button switch with the rotary switch in the "transmit" position. This enables a coded call to be used to identify which shore station is required on the shared frequencies and whether the river or seaward directional aerials are to be used at the Port Radar Station.

Provision is made for connecting an amplifier and loud-speaker for use in addition to the handset, but it has not been found necessary in practice to supply this equipment.

The limitations of size and weight restricted the power of the transmitter to ¼ watt and the receiver sensitivity to not more than 10 microvolts.

Shore Stations

The requirements specified for the shore stations were not so rigid as for the portable sets, no limit being placed on size, weight or power. They had to be capable of being operated by comparatively unskilled staff; all tuning was to be pre-set, and the only control was to be a send receive switch.

Fig. 4. A portable equipment

The major problem in the scheme was to obtain the minimum range of 23 miles from the Port Radar Station on Channel 1, in view of the low transmitter power of the portable sets. Fortunately the geographical relationship between the main approach route to the Bar and the Port Radar Station is such that the extreme range is required only over an arc of some 20–25 degrees.

The aerial power of the ground stations is 45 watts, the receiver sensitivity being about 2 microvolts. For Channel 1 seaward, the aerial is a 32-element centre-fed beam with a meshed metal reflector giving a gain of some 18 decibels, with a theoretical beam width of ±13 degrees to ½ power. The centre line of this beam is on a bearing of 287 degrees true, which intersects the approach course from Lynas at a range of about 23 miles.

This aerial is approximately 30 feet high and 12 feet wide. It is mounted on a steel lattice tower 80 feet high, situated approximately 50 feet from the Port Radar Control Room (Figs. 5 and 6).

Channel 2 at Port Radar requires an operational range of 14 sea miles, and a Yagi-type aerial, with one driven element and four directors sighted in a direction of 295 degrees true to the Bar Light-vessel, is mounted on a metal mast extending 20 feet above the beam aerial mounted on the same tower. Subsequently a second similar aerial was erected some six feet below the upper Yagi to improve the performance on this channel.

It is also necessary for Channels 1 and 2 to operate into the river for radar aid etc., but the range in this case would be very much less. Two similar Yagi aerials are mounted on the 20-foot pole mast looking riverward, one for Channel 1 and one for Channel 2.

The V.H.F. aerial tower extends above the height of the radar scanner but is situated in the shoreward arc, from which radar signals are not required, and therefore does not interfere with the performance of the radar.

For the dock stations, the Yagi-type aerials are used in all cases, but as the maximum range required is only eight miles, they are mounted on masts 40 feet above ground level.

There are three separate types of ground stations, two of which are installed at Port Radar, the third type being installed at all the remaining dock stations.

For Channel 1 at Port Radar, the equipment is designed to provide 100 per cent. of standby units. These are housed in a steel cabinet approximately 6 feet high, 21 inches wide and 21 inches deep (Fig. 7). The units fitted in the cabinet comprise two transmitters, three receivers and two power units. Two receivers are always in operation connected to the two separate aerials, one beamed seaward and the other looking riverward, while the selection of aerial for transmission is done by a switch situated on the remote telephone unit, which is similar in operation to a Plan 7 Post Office desk telephone, with the addition of a "press to talk" switch in the handset. Separate loud-speakers are fitted in the Communications Room and the Radar Room to listen for calls. A desk-type telephone handset is fitted in the Communications Room, but at the radar console a headset with a breastplate transmitter is fitted in two positions, from each of which four of the displays can be observed.

Separate controls are fitted for each position, by which it is possible to select the river and seaward aerials for both Channel 1 and Channel 2 and also for the broadcast of navigational information, in which transmission takes place on both channels

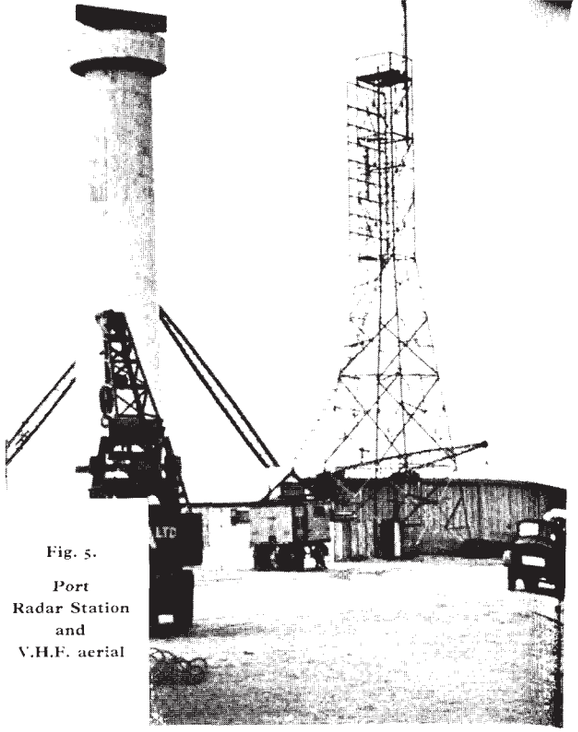


Fig. 5. Port Radar Station and V.H.F. aerial

and in both directions simultaneously. A separate 3-position switch in each control selects receive transmit or intercommunication between the Communications Room.

In the event of a breakdown of a transmitter, a receiver or a power pack, only the appropriate plugs need be altered to restore full service.

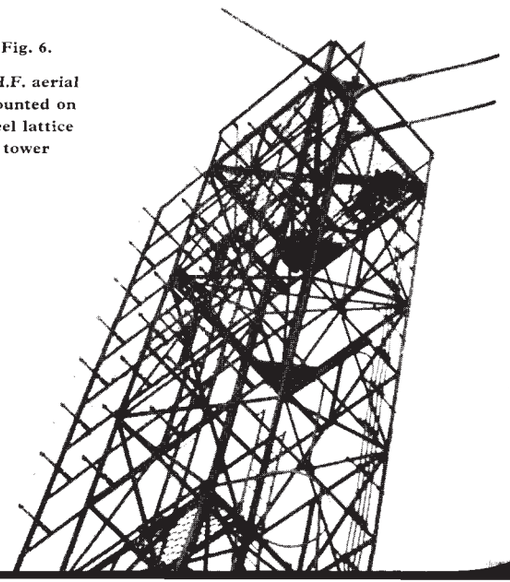


Fig. 6. V.H.F. aerial mounted on steel lattice tower

On Channel 2 at Port Radar, the equipment is housed in a steel cabinet approximately 40 inches high, 21 inches wide and 21 inches deep (Fig. 7). The units fitted comprise one transmitter, two receivers and one power unit, no standby units being supplied. The control is the same as for Channel 1, a separate Plan 7 desk telephone being provided in the Communications Room, which can be switched through to the radar console. The two receivers listen in the riverward and seaward directions, the transmission direction being selected as described above. Fig. 8 shows the Channel 1 and Channel 2 equipments in their positions in the Communications Room at the Port Radar Station.

The dock station equipments are contained in cabinets similar to that for Channel 2, but without the second receiver, as it is necessary at these stations only to listen in one direction on a single aerial. The place of the second receiver is occupied by a drawer containing spare valves etc. for maintenance, to save the maintenance engineer's carrying a large number of spares with him. It also houses a monitor telephone for test purposes. Operation is from a remote unit similar to a normal desk telephone set with a "press to talk" switch in the handset. A small loud-speaker to indicate an incoming call is fitted in the position where the automatic dial is normally situated. This loud-speaker is automatically switched off on lifting the handset.

The main units employ standard Post Office 19-inch panels and are withdrawn on telescopic runners from the cabinet housing. The transmitter and receiver units are divided into sub-units to aid in maintenance. The power unit is not sub-divided.

A complete set of main units and additional sub-units is kept at the central stores to enable a faulty unit to be rapidly replaced and obviate delay in fault finding at the station, the faulty unit being taken back to the central workshop for repair.

The cabinets are fitted with steel doors, with locks to prevent interference by unauthorised persons.

The power supply is from the mains. A separate motor alternator is provided for each channel at the Port Radar Station, where the supply is D.C. In the dock stations, where the supply is A.C., automatic voltage regulators are fitted.

Future Developments

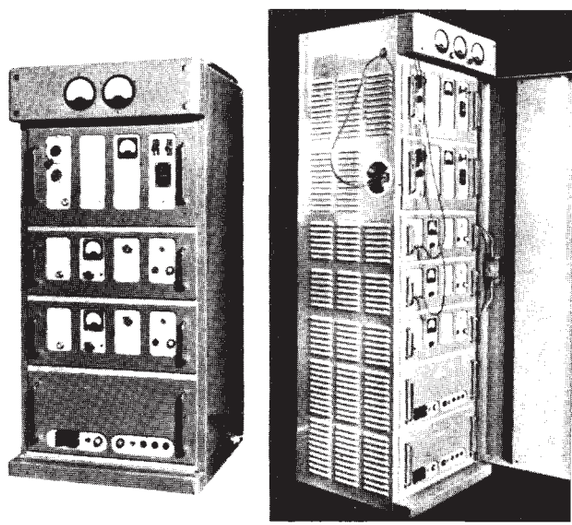
The present system is adequate as far as the pilotage services to vessels are concerned, but it is hoped that in future an increasing number of regular traders to the port will be fitted with permanent ship-board V.H.F. installations and thus reduce the number of portable equipments to be maintained.

The manufacturers of the radar and the V.H.F. telephone equipment have collaborated to produce a modification in the portable sets, to enable the set to transmit a signal on the radar frequency, to aid positive identification of vessels on the radar screen. The problem of the identification of vessels requiring radar assistance has not given rise to any difficulties during the three and a half years the radar station has been in operation, and although successful trials have been carried out with the modified equipment, in view of the expense involved it has been decided not to modify the equipments in use at Liverpool, although such facilities might be of great value in conjunction with shore-based radar installations at other ports.

Permanent ship-type installations have been ordered and will shortly be delivered for the larger dredgers and the salvage and buoyage vessels belonging to the Board.

The construction of training walls bordering the main sea channels involves transporting large quantities of stone by sea from quarries on the north coast of Wales and Anglesey. A scheme has been approved by the G.P.O. and will shortly be in

Fig. 7. Cabinets for Channel 1 (right) and Channel 2 (left)



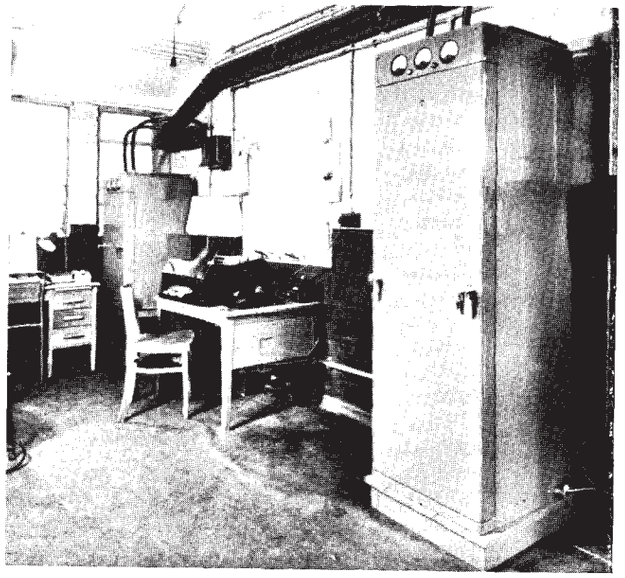


Fig. 8. Communications Room at Port Radar Station

operation for installing a shore V.H.F. equipment operating on Channel 6 at Point Lynas Lighthouse with ship-borne installations in the six vessels employed in carrying this stone, to facilitate loading and, if necessary, passing diversion instructions to them. The quarries are a few miles to the eastward of Point Lynas.

Although it has not been possible to determine the financial saving to shipping interests through the provision of the communications services and the Port Radar Station, there is no doubt that it is considerable. A 12-hour delay in docking may cost the owner of a vessel as much as £500, and on several occasions owners have stated that they have saved one or more tides.

It will be appreciated that the traffic handled by the Harbour Communications Service could not be handled by, and in no way infringes upon, the public communications services, either by wireless telegraph or radio-telephone link. The greater part of the message traffic now dealt with through V.H.F. radio-telephony was previously handled by visual signal from the shore or by verbal or written messages taken off to vessels by tugs.

I should like to acknowledge the assistance I have received from the Automatic Telephone and Electric Company in preparing this article, particularly in the provision of illustrations.

Report on Interference

The Postmaster-General's Advisory Committee on Wireless Interference from Refrigeration Apparatus, appointed in July, 1950, recommends that apparatus, new or otherwise, should comply with certain requirements as regards voltage of interference. The recommendations are based on the assumption that users of sound and television receivers will take reasonable precautions to safeguard them from interference.

The interference voltage injected for continuous periods of not less than one-fifth of a second, or more frequently than once in any two-second period, into the electricity supply mains should not exceed 1,500 microvolts for frequencies of 200—1,605 kilocycles per second (the major part of the broadcast band) or 750 microvolts for 40—70 megacycles per second (the present television band).

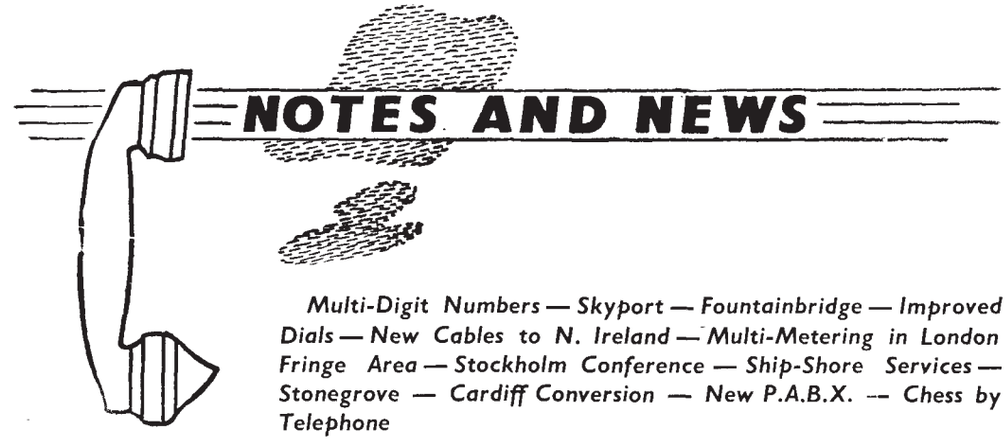
The Committee understands that suppressors are fitted at present by reputable manufacturers to new refrigeration apparatus as required and it observes that compliance with the requirements is implicit in observance of the latest British Standards for household refrigeration apparatus. The Committee is satisfied that financial hardship to owners or purchasers of existing or new apparatus is unlikely to arise through enforcement of the requirements.

Editorial Change

After a short but valuable period of office, Mr. F. E. Ferneyhough has relinquished the post of Editor of the *Journal*, as a result of his appointment as Telephone Manager, Southampton.

One of his greatest problems when he took over was the serious delay in publication caused by difficulties in the printing world, but he was not discouraged. All problems—and the Editor has his full share—he tackled with skill and cheerful enthusiasm, and the *Journal* owes him a great deal. In going to his new job, he takes with him our warm thanks and best wishes.

In the office of Editor he is succeeded by Mr. John L. Young, who joined the Post Office in 1950 on transfer from Cable and Wireless, Ltd., where he had been Deputy Public Relations Officer. For some years he was the Editor of "World's Press News" and associated journals, and he brings to the *Journal* a wide experience of editorial work and of all aspects of printing and typography.



Multi-Digit Numbers — Skyport — Fountainbridge — Improved Dials — New Cables to N. Ireland — Multi-Metering in London Fringe Area — Stockholm Conference — Ship-Shore Services — Stonegrove — Cardiff Conversion — New P.A.B.X. — Chess by Telephone

Five and Six Figure Subscribers' Numbers.—Hitherto some hesitation has been felt about introducing 6-figure telephone numbers in Britain, on the grounds that subscribers might regard the numbers as complicated and difficult to remember. However, 6-figure numbers have been adopted with success in other countries, and they are in general use in Europe and the Dominions and in a number of exchanges in America.

When the number of telephones in a non-director area has approached the limit of a 5-figure numbering scheme, the policy in Britain hitherto has been to convert such areas to 7-digit (3-letter, 4-figure) director working. This, as well as involving some wastage of equipment and increased capital expenditure, requires wholesale number changes, and during the change-over period, which may be 10 to 15 years, necessitates a mixed and often complicated system of dialling in the automatic area.

In view of these very real difficulties, renewed consideration has been given to the introduction of 6-digit numbers in this country. As a result, it has been decided that future telephone development in provincial towns of medium size should be planned on a non-director basis, using mixed five and six-digit numbering schemes. The immediate effect of this decision is that the Bristol and Leeds automatic areas, which were due for conversion to director working, will now continue on a non-director basis, using six-digit numbers where necessary.

★ ★ ★

Trunk Calls at Christmas and New Year.—In recent years, the evening cheap rate for trunk calls has been suspended throughout the United Kingdom on three days at Christmas and on New Year's Day, with the object of freeing from duty on those days some of the evening operating staff.

For the past two years, however, in order that staff relief could be given on the days most appropriate to the staffs north and south of the Border, the suspension was: *Scotland*—25th and 31st December and 1st and 2nd January; *Rest of U.K.*—24th, 25th and 26th December and 1st January.

This arrangement has proved to be more satisfactory. On these evenings, traffic levels were 25 to 40 per cent. below those of a normal evening and, in general, each member of the operating staff was free on at least one of the holidays.

★ ★ ★

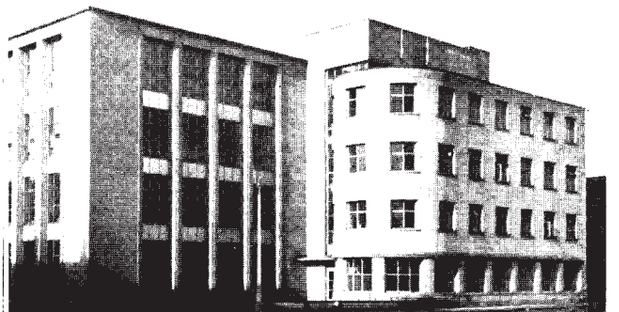
Skyport.—Work has started on building London Airport's new automatic exchange, Skyport, and is expected to be completed by 1954, to coincide with the opening of the new terminal buildings.

The present switchboard handles 3,000 incoming and 2,000 outgoing calls every day. When the new

automatic exchange is installed, it will be expanded to include new lines for the ever-increasing number of firms on the airport, but the 1,000 extensions all over the airport will continue to be used for internal calls.

★ ★ ★

Fountainbridge, New Exchange.—Another phase in the conversion of the Edinburgh telephone system to director working is nearing completion and was marked by a ceremonial opening of the new building in Fountainbridge (illustrated below) and of the new trunk switchboard and directory enquiry suite in it. The upper photograph shows the Postmaster-General receiving a golden key from the managing director of the building contractors. On the Postmaster-General's left is Colonel Gardiner, Director of the Post Office in Scotland: on his right, Mr. Ramsay, Telephone Manager; the Lord Provost of Edinburgh; and Sheriff Principal Gilchrist. In the background the Earl of Selkirk; Mr. McCallum, Head Postmaster; Mr. Tom Oswald, M.P.; and Mr. Macintyre, Under Secretary, Ministry of Works Scottish Headquarters. The ceremony took place in the new switchroom, a special platform being installed and draped by the Ministry of Works.



999.—The number of telephone calls from the public received in the information room at Scotland Yard in 1951 totalled 102,271—a record. Some 95 per cent. of these calls were made by callers dialling 999 and being connected to the police by the Post Office emergency call operator. As a result of these calls, the crews of area wireless cars made 9,869 arrests. During 1950, 90,939 such calls were dealt with at Scotland Yard and the arrests totalled 8,905.

★ ★ ★

Improved Call-Office Dial.—Dials with the trigger-type mechanisms but with Diakon dial labels are now being fitted in call offices in the normal course of maintenance. The labels are transparent and have the characters on the back, thus obviating the trouble experienced from wear and tear with the present vitreous-enamel dial plates.

★ ★ ★

New Cables to Northern Ireland.—Two new Portpatrick-Belfast submarine cables, with a total capacity of 120 channels, were completed in the latter part of last year and arrangements were made for working circuits to be transferred to these new cables, so that the existing cables could be re-equipped to a capacity of 120 channels. Re-equipment of the existing cables is planned to take place in two stages, and it is intended that 60 channels shall be provided by the 1st May, 1952, and the remaining 60 by the 1st July, 1952.

★ ★ ★

Multi-Metering Facilities in the London Fringe Area.—Subscriber dialling has been introduced from Slough exchange (which is practically on the boundary of the 20-mile circle) to London director exchanges that are within the 5-mile circle. The Slough subscribers, who have non-lettered dials, dial 7, receive a second dialling tone and then dial a 3-figure code followed by the 4 digits of the subscriber's number. Within a week of the introduction of dialling from Slough to London, over 93 per cent. of the traffic proper to be dialled was being handled automatically, saving 9 operators in the busy hour at Slough. This result is a useful indication of the way in which subscribers are prepared to refer to rather long lists of numerical codes.

★ ★ ★

Stockholm Conference.—The United Kingdom has accepted an invitation from the Secretary-General of the International Telecommunication Union to attend a conference in Stockholm to consider the assignment of very high frequencies for television and sound broadcasting services in the European Area. The conference is planned to start at the end of this month.

★ ★ ★

Long-Distance Telephone Exchanges—Record Number of Visitors.—During 1951, the record number of 12,165 people visited International, Continental and Trunks Telephone Exchanges in the City of London. The previous highest number was 10,126, in 1949.

Many of the visitors were from Commonwealth and foreign countries. The remainder were representative of all parts of the United Kingdom. A large proportion came in organised parties of students, cadets, scouts, members of social and political clubs and professional associations. Their letters express appreciation of an exciting, instructive and interesting experience. All were impressed by the organisation and efficiency of the service, and they paid special tribute to the staff who acted as guides.

★ ★ ★

Ship-Shore Wireless Services.—During 1951, more than 407,359 ship communications were dealt with by Post Office coast stations, 826,640 radiotelegrams totalling over 12,900,000 words were exchanged between vessels and coast stations, 29,211 radio-telephone calls were handled, and 830 messages were received from aircraft.

On the "Safety Service" side of coast station activities, 275 distress calls were dealt with and 469 medical messages from ships at sea were handled. Post Office coast stations maintain a continuous watch for distress calls from ships at sea, and when such a call is received the station immediately ceases all commercial transmitting and directs its attention to establishing communication with the ship concerned.

★ ★ ★

New London Telephone Exchange.—A new automatic telephone exchange named "Stonegrove" was recently opened to serve part of the Edgware district and relieve Edgware Exchange. Stonegrove is the local name for a district in the area served by the new exchange.

★ ★ ★

Cardiff Telephone Exchange Conversion.—On Saturday, 16th February, the Postmaster-General opened a new automatic exchange to serve the Cardiff area.

The manual exchange at Cardiff had been in use for more than 40 years and Cardiff was the last of the main trunk switching centres to be provided with the automatic system. The new exchange is of the more modern design and is the largest single unit of automatic equipment ever to be brought into service at one operation in Great Britain.

New telephone numbers to be used from the time of the changeover have been assigned to Cardiff subscribers. Long-distance calls to the old Cardiff numbers are intercepted and the caller is informed of the new number before the call is connected.

★ ★ ★

Telephonist Recruitment in London.—Intending recruits for telephonist posts in London exchanges may now, if they prefer, apply direct to the Supervisor of their local exchange, instead of to the Regional Director's Office in central London. Would-be telephonists are thus given an opportunity not only to see the switchroom but also to obtain, at first hand, an account of the various exchange activities.

★ ★ ★

New Standard P.A.B.X. (large type).—The first P.A.B.X. of the new standard No. 3 type, fitted with about 250 extensions, has been working for some months at Australia House, London, and appears to be giving every satisfaction. The three operating positions are neat in appearance and the apparatus at the back of the positions is laid out so as to give every assistance to the maintenance staff. The press-button recall facility, which causes a supervisory lamp to flash continuously until the operator enters circuit, is much appreciated by extension users and operators alike.

★ ★ ★

Chess by Telephone.—Chess is not a game that figures much in the news, but the leaflet on Chess by Telephone issued recently aroused widespread interest. Organisers of matches will welcome the information that they can arrange their fixtures to take place over the telephone at a cost little more than half that of a long trunk call.

Local clubs all over the country connected with the British Chess Federation have been notified in

the B.C.F. Year Book of the special facilities they may use for playing matches by telephone.

Such matches require special organisation and the use of tellers to arrange to collect for transmission the moves made on each board and to record and give to the players the moves received over the telephone from the opponents. On the other hand, the trouble and expense of travelling is saved.

The type of telephone service offered is not a new one—it was introduced before the war—but few players seemed to know of its existence and the attention thus drawn to it may not only stimulate trunk telephone traffic during normally quiet periods, but also encourage matches between towns that are far apart.

The contract calls, as they are named, are arranged by local Telephone Managers and can take place whenever traffic conditions permit, as they usually do during evenings and week-ends, when most matches take place. These calls cost three-quarters of the ordinary telephone charge for the first half-hour, plus half the normal fee for the remaining time. Thus a London–Nottingham call of four and a half hours would cost players a total of £3 18s. 9d.

Book Review

POST OFFICE, 1951. Obtainable from H.M.S.O., most Head Post Offices and booksellers. 64 pp. text and 20 pp. photographs. Price 3s. 0d.

This publication does all it sets out to, and more. It reviews the activities of the Post Office during 1951 in a manner informative, entertaining and thrilling. Telecommunications, in which we are primarily interested, occupies a large proportion of the space, with articles on cable ships (in peace and war), the "999" services, inland trunks, ship-shore radio stations, scrap recovery and contracts. The treatment is popular, but there is also a modicum of subject-matter for the technically minded.

Apart from the absence of capital letters from certain headings—we deplore, in particular, "festival of britain"—the most punctilious reader will find little at which to cavil. Statistics there are in plenty, but not so obtrusively presented as to mar the enjoyment of the general reader. Some of the photographs are taken from unusual angles, and most of them, we think, have never been published before. The layout and cover design are admirable.

Editorial Board. R. J. P. Harvey, C.B. (Chairman), Director of Inland Telecommunications; H. A. Ashton, C.B.E., Deputy Regional Director, North Western Region; C. O. Horn, Deputy Regional Director, London Telecommunications Region; A. F. James, Assistant Secretary, Personnel and Accommodation Department; A. Kemp, Assistant Secretary, Inland Telecommunications Department; Dr. W. G. Radley, C.B.E., Engineer-in-Chief; Col. A. H. Read, O.B.E., T.D., D.L., Director of Overseas Telecommunications; F. B. Savage (Assistant Editor), Public Relations Department; L. F. Watling, Public Relations Department; John L. Young, (Editor), Public Relations Department.

Regional Representatives. E. A. Bracken, Welsh and Border Counties Region; W. G. N. Chew, Engineer-in-Chief's Office; R. Oliver, Contracts Department; S. J. Giffen, Northern Ireland Region; J. E. Golothan, South Western Region; W. Millman, North Eastern Region; K. Ridehalgh, Home Counties Region; E. W. Sansom, London Telecommunications Region; H. Scarborough, Scotland; J. E. D. Stark, Midland Region; W. Tansley, North Western Region.

Publication and Price. This Journal is published in November, February, May and August. Price 1 -. The annual postal subscription rate is 4 6 post free to any address at home or overseas.

Copyright. Copyright of the contents of this Journal is reserved. Application for permission to reprint all or part of any article should be addressed to the Editor.

Advertisements. No official responsibility is accepted for any of the private or trade advertisements included in this publication. Communications, advertisement copy etc. should be addressed to Aubrey W. Hammond, Ltd., Spencers Farm, Horsham, Sussex. (Tel. Horsham 760.)

Contributions. The Editorial Board will be glad to consider articles of general interest within the telecommunication field. No guarantee of publication can be given. The ideal length of such articles would be 750, 1,500 or 2,000 words. The views of contributors are not necessarily those of the Board or of the Department.

Communications. Communications should be addressed to the Editor, Post Office Telecommunications Journal, Public Relations Department, Headquarters G.P.O., London, E.C.1. Telephone: HEAdquarters 4330. Remittances should be made payable to "The Postmaster General" and should be crossed "& Co."

Post Office Telecommunications Journal

Published by the Post Office of the United Kingdom to promote and extend knowledge of the operation and management of telecommunications

Contents

page 129
PRESS ASSOCIATION'S PRIVATE WIRE SYSTEMS
E. W. Davies

page 133
TELEVISION AND SOUND BROADCASTING BY WIRE
F. Hollinghurst

page 138
TRAINING WAR BLINDED TELEPHONISTS
J. W. Tatum

page 143
RELIEF OF OVERLOAD AT A MANUAL GROUP CENTRE
E. L. Perkins

page 147
FIRE FORCE COMMUNICATIONS
E. A. Smallwood

page 153
COMMONWEALTH TELECOMMUNICATIONS BOARD
Col. W. W. Shaw-Zambra

page 160
MICRO-WAVES
W. J. Bray

page 164
NOTES AND NEWS

★

Vol. 4 *AUGUST-OCTOBER, 1952* *No. 4*

The price of the "Journal"

THE PRICE OF THIS JOURNAL WILL BE INCREASED with the next issue—which will be for the quarter November, 1952, to January, 1953—from 1s. to 1s. 6d. a copy.

The annual subscription will be increased correspondingly from 4s. 6d. to 6s. 6d. post free. Current subscriptions will be valid at the existing rate until they expire, but all renewals and new subscriptions received after August 10, the date of this announcement, will be payable at the new rate.

The Editorial Board regret the necessity to increase the price, but with increased costs this is unavoidable. Nevertheless, they believe that, considering the general level of current prices, the "Journal" is worth the higher rate; it has been sold for one shilling a copy since publication began in November, 1948, although, after the first two issues, the number of editorial pages was raised from twenty-eight to forty-two.

The Board believe also that readers will share their view that, at 1s. 6d. a copy, the "Journal" will remain good value for money.

Left to right: F. A. SMITHERS, A.M.I.E.E., Area Engineer; F. W. WILKES, Chief Clerk; F. O. WATSON, Telephone Manager; J. HINDLEY, Senior Sales Superintendent; V. H. G. PAGE, Senior Traffic Superintendent.

LINCOLN TELEPHONE AREA

The Lincoln Area, covering as it does 2,029 square miles, made up of North Lincolnshire and parts of Nottinghamshire and the West Riding of Yorkshire, is one of pleasing contrasts, which range from Lincoln itself, with its magnificent cathedral—"The Jewel of Europe"—and a history going back to pre-Roman days, through pleasant and fertile agricultural districts to the modern steel town of Scunthorpe.

Industrially, too, this Area is one of contrasts: coal mining near Doncaster; fishing at Grimsby; steel at Scunthorpe; oil at Immingham and bulbs at Spalding; and from the engineering works at Lincoln but a short distance to placid inland waterways beloved of fishermen.

From the telephone point of view, Lincoln's post-war effort has been great. Service has been provided for 25,000 new subscribers, nearly 2,000 of whom are farmers, many of whose long lines created a special problem. This again reflects the diversity of the Area, since provision of service was assisted greatly by mechanical pole-erecting and cable-laying aids—the latter first used during the war to meet the problems of service to some 40 aerodromes.

READING TELEPHONE AREA

The Reading Area lies in the heart of the County of Berkshire, but includes portions of Oxfordshire to the north, Buckinghamshire to the east and Hampshire to the south.

It embraces some of the most beautiful scenery of the Thames Valley, the picturesque villages of the Chiltern Hills and the rolling Berkshire Downs with their prehistoric associations. The Thames flows through the Area, bordered by the picturesque towns and villages of Goring, Streatley, Sonning, Pangbourne, Marlow, Maidenhead, Eton and Windsor.

Left to right: (standing) Maj. L. W. LOVEGROVE, Area Engineer; F. J. LANE, Senior Sales Superintendent; J. S. WILKIE, Chief Traffic Superintendent; (seated) Miss E. M. POCOCK, Higher Executive Officer (Secretary); C. R. FRIGHT, M.B.E., Telephone Manager; A. LYNCH, Chief Clerk.

Reading, the largest town in the Area, has a world-wide reputation for its biscuits, beer and seeds. It is also the seat of one of the newer universities. Next in importance commercially is Slough, a thriving community with varied business interests. The nearby film studios at Iver provide a fluctuating traffic load at the local exchange.

On the sporting side, the Area is noted for the racecourses at Ascot and Newbury and for the numerous horse breeding and training stables on the Berkshire Downs. Henley-on-Thames, home of the famous Regatta, attracts oarsmen from all over the world.

Bracknell New Town, designed to relieve a congested area in London, is beginning to take shape, and the London County Council has ambitious plans for the development of the area east of Slough. To the west, the rural seclusion of Silchester (the Calleva of Roman days) is being awakened by an expanding establishment at which the mysteries of atomic power are being investigated.

Area, approximately 900 square miles—number of exchanges, 74 (40 auto., 34 manual)—exchange lines, 37,132 — stations, 69,258 — total staff, 780 — annual revenue, £1,500,000.

The Press Association's Private Wire Systems

by Edward W. Davies, General Manager, Press Association

THE PRESS ASSOCIATION, FOUNDED IN 1868 and owned entirely by the proprietors of Provincial newspapers, is the biggest Home News Agency in the British Isles. It both collects and distributes Home News of all kinds, and in addition it serves newspapers outside London with World news, mainly from the great British agency Reuters (of which the Press Association is a part-owner), and also from the Associated Press.

The P.A.'s main problem of communications is therefore to deliver news as quickly as possible, day and night, seven days a week, to more than 130 morning, evening and Sunday newspapers outside London; and in London there is an entirely separate Home news delivery to the London newspapers, London offices of big provincials, the B.B.C., and to Reuters and their "allies" (London offices of overseas newspapers and news agencies) who see to it that important news from Britain goes all over the world.

The biggest item in the communications system is the P.A.'s private telegraph network, whereby the news is transmitted direct from London into the offices of the provincial subscribers. No other home news agency has such a large private-wire system, which reaches as far as Aberdeen in the North and Cork in the West. The main object of this article is to show how it developed and what it is today.

Throughout the whole of its life, the P.A.'s connection with the Post Office has been close and continuous.

From 1870, when the first P.A. news message was sent, to 1920 all news was distributed (except to the London newspapers served by messenger) by means of Post Office press telegrams. The G.P.O. had a special staff to deal with press work and their skill and knowledge was considerable, but it was clear even before the 1914–18 war that newspapers served only by press telegram could not get their news with the same speed and flexibility as the big provincial newspapers, who rented circuits from the Post Office and transmitted with their own apparatus direct from their London to their provincial offices.

So the idea grew that the P.A., by renting Post Office circuits and installing the necessary transmitting and receiving apparatus, should operate its own private telegraph system. A strong advocate of this plan was the late Mr. G. B. Hodgson, Editor of the *Shields Gazette*. In 1920 he became Joint General Manager of the P.A., and with the full co-operation of his colleague, Mr. H. C. Robbins (now retired), the scheme was pressed forward. The Post Office advisers were most helpful. April, 1920, saw the opening of the first circuit, from London to Bristol with a forked repeater which extended the service to Wales and Devon. Other circuits followed, until every important provincial morning, evening and Sunday newspaper was connected. The Creed-Wheatstone system of automatic Morse transmission, which had proved its worth during the 1914-18 war, was the method adopted.

P.A., London, transmitted to P.A. telegraph centres in Birmingham, Bristol, Glasgow, Leeds and Manchester. These in turn re-transmitted the punched tape to the newspaper offices in their area (Ireland was covered by serving Belfast from Glasgow and Dublin and Cork from Manchester). It need hardly be added that all circuits, then as now, were rented from the Post Office and the transmitting and receiving plant were provided in their own offices by the P.A. and the newspapers jointly.

The first Chief of the P.A.'s Telegraph Department was Mr. J. Newlands, formerly with the Post Office. He was succeeded in 1934 by the present Chief, Mr. Leonard Warren, who has supplied a great deal of the technical information in this article.

The Creed-Wheatstone system was successful from its inception. Provincial newspapers which had previously not enjoyed private-wire facilities were able to publish up-to-the-minute news on level terms with bigger contemporaries, and the latter also obtained better service than they had secured before from the use of their own leased wires; but the very success of the plan was ultimately its undoing. Able to send out more news at greater speed,

the P.A. increased the quantity and variety of its services, but the thirst of the newspapers for yet greater and more varied supplies was unslaked. Those were the days of cheap and abundant newsprint, with competition tending always to increased newspaper sizes. Thus the traffic grew beyond the limits of what the network could conveniently carry.

The omnibus method of working was extravagant in line time, because although high speeds were possible during automatic transmission, output dropped to zero while RQs and corrections were being received. The need to transmit "special" items of news to particular newspapers also slowed down the general traffic, and there were the normal handicaps of occasional delays and interruptions. The result was that traffic accumulated in London and delay during peak periods became a problem.

In the meantime, developments in the Post Office, in both equipment and cable construction, had opened up a wider field, and multi-channel V.F. systems were being introduced to displace the single line working. While retaining the Creed-Wheatstone system, the P.A. installed in London, Manchester, Leeds and Glasgow the Standard Telephone Company's V.F. equipment adjusted for high-speed working.

When, in the middle of 1938, the present General Manager of the P.A. took over, it was clear that a major expansion of the private-wire system was needed, and this was in principle approved by the Board of Directors, but the delays caused by occupying a new building were followed immediately by the War, and everything had to be postponed until 1945.

An experimental circuit was set up on a 4-channel basis. This removed all doubt (if any existed) as to the efficiency of multi-channel V.F. teleprinter working. As a result of these extensive trials, it was decided to proceed with the reorganisation of the system, but meantime the P.A. had to maintain a continuous service of news and the problem was how to change to the new system with a minimum of interruption. A decision was made to relinquish the physical lines and replace them by V.F. circuits equipped with the Association's own V.F. equipment, identical to that adopted by the Post Office.

In addition to the five provincial centres already mentioned, it was decided to establish one at Newcastle, so as to provide a ring main line network London - Manchester - Glasgow - Newcastle - Leeds-London, the remaining two centres being linked London - Birmingham - Bristol - London, thus giving alternative routes to all centres. These were connected by 4-wire circuits equipped with full 18-channel duplex systems, except in the case of Glasgow-Newcastle and Birmingham-Bristol, which are equipped with 12-channel systems and serve newspapers situated between those points. Gradually, as and when further V.F. circuits became available, the newspapers were joined to their respective area centres and each newspaper situated some distance from its area centre was fitted with 6-channel equipment, while newspapers in the same town as a centre are supplied by means of direct current extensions. Facilities were also provided on 6-channel links for each newspaper to have an independent speaker channel back to its centre.

The new installation was a very big job for the P.A.'s telegraph chiefs and mechanics, who had not only to plan and effect the re-equipment in London and all the centres, but also to give advice and aid to many newspaper offices. Every newspaper wire room had to be reorganised for the new system, and although a number of the newspapers were already familiar with multi-channel teleprinter working, there were many to which it was a completely new and rather formidable proposition.

During the preparatory period, the Creed-Wheatstone system was still operated on one of the six V.F. channels. As machines became available,

In the Telegraph Room

the teleprinters were brought into use alongside the Creed-Wheatstone and trial transmissions were made daily until the whole system was built up. By the time the last circuit was available, most of the subscribers had had the benefit of becoming thoroughly acquainted with the new method of transmission.

Eventually, in May, 1949, it was possible to abandon Creed-Wheatstone and change over to teleprinter working on a 6-channel broadcast. From the beginning the scheme proved a success, and although in some cases one channel was still retained for Morse in case of emergency, it was not long before all the newspapers went over entirely to the new system. The result was that a flexible and efficient instrument for news transmission was available. Instead of one Morse channel working at 120 w.p.m., 6-channel working at 66 w.p.m. per channel was available, capable of transmitting roughly 400 w.p.m. This increase in carrying capacity, though obviously important, is far from being the sole advantage of the new set-up.

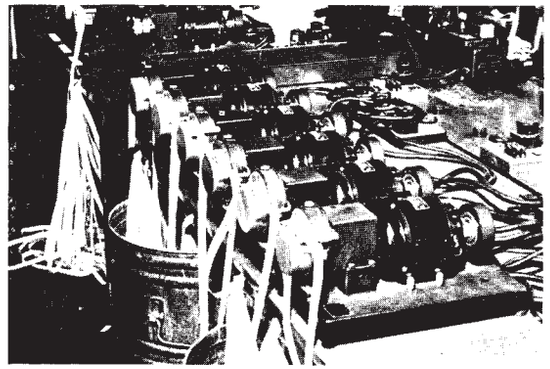
All newspapers are now served direct from London on a broadcast basis, so that each subscriber receives the same items of news at precisely the same moment. As each subscriber has return facilities, there is no need to stop the outward flow of news in order to collect acknowledgments. Racing results and "special" items can be sent over particular channels without interference with other news. Thus the greater carrying capacity of the system is enhanced by the lack of interruptions. Finally, "printing-up" of tape in the newspaper offices is a thing of the past, as the news is printed in page form by the receiving teleprinters, ready at once for the attentions of the sub-editors and the linotype operators.

Although the branch circuits are equipped with only six channels, they have similar characteristics to the main routes. The frequencies used on the branch lines are 420 cycles, 540 cycles, 2100 cycles, 2220 cycles, 2340 cycles and 2460 cycles. Frequencies between channels 2 and 15 are reserved for a picture band, as will be explained.

Each provincial newspaper office is equipped with a minimum of eight teleprinters (six receiving only and two transmitter-receivers), and a V.F. "intermediate" or terminal bay according to its position relative to other offices on the circuit. Thus, with six channels in use, at least two machines can be rested for maintenance every day and are available as spares in the event of trouble with one of those in use.

With the teleprinter network completed, attention was given to developing a wired picture broadcast simultaneously with the news service. Special filters were designed and, after long periods of trial and error, accurate data were available for their manufacture. On the main lines, the middle frequencies are patched out while pictures are being transmitted, but no patching is required on the branch lines. It will thus be seen that newspapers over the whole country can receive pictures and six channels of telegraphs simultaneously. The P.A. scheme may not be unique, but it does present a compact arrangement which uses all available frequencies to the best advantage.

The carrying capacity between centres will shortly be augmented by the introduction of group modulation, which will add six more channels to each of the provincial centres, giving twelve news channels and pictures on the main route and six



Transmitters for the six provincial channels

news channels and pictures on the branch lines serving individual newspapers.

In the P.A.'s London telegraph system, it has not been necessary to adopt V.F. working. Automatic transmission over the separate channels of three teleprinter installations give the London subscribers their Home news. On suitable occasions, one of these transmitters is "switched in" to one of the channels of the provincial system, so that one punching and one transmission convey the news to the whole of the subscribers. At other times—on account of differences between the news services—the two systems operate independently.

By the side of all this progress, a link with the past remains. Some smaller provincial newspapers not connected with the private wire system still receive their news by press telegrams through the Post Office.

Television and Sound Broadcasting by Wire

by F. Hollinghurst, B.Sc.(Eng.), A.C.G.F.C., M.I.E.E.,

Engineer-in-Chief's Office

(In the course of the following article, some comparisons are naturally made between the direct reception by radio of broadcasting programmes and the reception of programmes by wire, but any assessment of the relative merits of the two systems is outside the scope of the article.—Editor.)

AS LONG AGO AS 1894, THE TELEPHONE systems in a few of the larger cities of Europe were used to enable subscribers to listen, in their own homes, to public entertainment, to lectures or to religious services. Microphones in the opera houses, theatres, halls and churches were connected through a special exchange to the telephone exchanges.

For more than 25 years, these systems perforce worked without the aid of amplifiers; their range of operation and the number of subscribers who could be connected simultaneously to the same place was therefore very limited. In London the "Electrophone Exchange" (as it was called) and the lines were provided for the Electrophone Company at first by the National Telephone Company and later by the Post Office. The number of electrophone subscribers had not reached 1,000 by 1919, but by 1922, when the British Broadcasting Company started working, this number had been nearly doubled. Although plans were then well in hand for extension and improvement of the electrophone service using valve amplifiers, it could not compete with its popular new rival and in 1925 the Post Office agreement with the Electrophone Company came to an end.

The latest use of British Post Office telephone lines in this way appears to have been in the Bournemouth area, where, until the mid-'thirties, a few subscribers continued to be connected to certain churches. In Holland and Switzerland, an elaboration of the system has continued to provide broadcast programmes over many subscribers' telephone lines, the programmes being interrupted when a call is made or received.

Radio broadcasting brought special programmes and news bulletins which were readily received by large numbers of listeners at a very low cost. For this and other reasons, radio succeeded, where the electrophone type of system had failed, in discovering and developing broadcasting as a near-necessity for the millions. Within a few years, listeners were soon spending as much on their radio receivers as was sufficient to support a system of programme distribution by wire, and such systems began to appear in urban areas.

The first relay exchange systems, as they were called, were virtually ambitious forms of the domestic extension loudspeaker. One such system, started in 1924 at Hythe, near Southampton, was the first to come officially to notice in the Post Office and in 1926 it was specially licensed to continue working. A still earlier example was at St. Annes, Lancashire, where, in November, 1922, when station 2ZY became the Manchester transmitter of the newly-formed British Broadcasting Company, a listener had already been relaying its experimental programmes to an extension speaker in a relative's house about 100 yards away from his receiver. In 1926, when this system was serving some 40 listeners, a company was formed to continue its development. A year or two later, the same group for a time rented spare Post Office lines, over each of which they offered a choice of two programmes, one at audio and another at carrier frequency, to their subscribers in St. Annes and in Lytham. Each subscriber had a crystal detector and a single-valve amplifier in addition to a loudspeaker.

Other systems were coming into use as the commercial possibilities of wire broadcasting were appreciated. By the autumn of 1927, there were 10 relay exchanges with 446 subscribers. The subsequent growth is shown in the table overleaf.

There are several methods of distributing sound programmes by wire. The domestic extension loudspeaker system is the most widely used. Instead of a loudspeaker in each of a few rooms

fed from one pair of wires from the output of a radio receiver, there may be up to 4,000 loudspeakers fed from an amplifier capable of an audio power output of as much as 2 kilowatts. Sufficient

Growth of Relay Exchanges in the United Kingdom

Date	Number of Exchanges	Number of Subscribers
September, 1927	10	446
December, 1928	23	2,430
,, 1929	34	8,592
,, 1930	86	21,677
,, 1931	132	43,889
,, 1932	194	82,690
,, 1933	265	130,998
,, 1934	318	192,767
,, 1935	343	233,554
,, 1936	333	250,978
,, 1937	331	255,236
,, 1938	325	256,294
,, 1939	284*	270,596
,, 1940	284*	297,691
,, 1941	278*	309,420
,, 1942	277*	435,073
,, 1943	275*	494,559
,, 1944	274*	551,763
,, 1945	274*	634,474
,, 1946	283*	714,505
,, 1947	297*	793,582
,, 1948	314*	865,539
,, 1949	335*	921,461
,, 1950	343*	960,771
,, 1951	371**	980,102*

**Excludes secondary or standby station.*
**Includes 4 television wire broadcast stations with a total of 326 subscribers.*

power is available from the line to work the subscribers' loudspeakers without the aid of individual amplifiers, so that they do not need power mains or batteries. A separate main feeder and separate subscribers' leads must be used for each programme, the selection being made by means of a switch to connect the loudspeaker to the required line.

For a large choice of programmes, or where listeners are relatively more scattered, it may be worth while for each listener to have more costly apparatus for carrier reception, the extra cost being offset by savings in the cost of lines. Carrier systems using specially erected wire networks have been in use since 1946; these systems distribute up to six programmes over a single main feeder, with a single lead taken from the feeder to each listener's house. At the relay exchange, apparatus equivalent to a very low-power radio transmitter feeds the carrier signals into the wire network. The receiving equipments are like very simple radio receivers.

Wire broadcasting in various forms has become popular in many places abroad. In those countries for which data are available—Germany, Holland, Sweden and Switzerland and the British colonial territories—about 1,000,000 listeners use wire broadcasting services. About half of these are in Holland.

In Germany, Sweden and Switzerland, carrier systems on subscribers' telephone lines are well established and are growing steadily. In their present form, these carrier broadcast services use the same subscribers' lines as the telephone service, without any mutual interference. In Germany, the carrier systems generally offer a choice from three programmes. In Sweden, as yet only one programme is available. In Switzerland, the carrier system is used to distribute five programmes for the listeners' choice and about one-fifth of the telephone subscribers have a wire broadcast service over the telephone lines, a growing proportion (about one-fifth at present) have the carrier service and the remainder use the older, low-level, audio system, which involves interruption of the programme for a telephone call to be made or received. In Holland and in British colonial territories, as in the United Kingdom, audio systems for which the listeners require only loudspeakers are most widely used.

Between 1936 and 1940, following Government decisions based first on the report of the Ullswater Committee and modified later for defence reasons, the Post Office had placed contracts for transmitting equipment for a four-programme system for carrier wire broadcasting using local telephone lines and ordinary long-wave radio receivers. The project was suspended in 1940, however, soon after war had broken out. Post-war experimental equipment is more compact and is capable of giving a choice of eight channels with improved quality, provided the listener uses a special 3-valve receiver. Four of the programme channels could be received on most ordinary long-wave radio receivers, but the quality would then be limited by the narrow frequency band for which radio broadcast receivers have to be designed to avoid interference from unwanted stations in the overcrowded medium and long wavebands. Such a system, like those in Switzerland, Germany and Sweden, in addition to increasing the scope of broadcast listening, would make more use of the very considerable local line assets in this country, which, on average, are in use for telephone calls for only about 20 minutes in every 24 hours.

When the B.B.C. 405-line television service first started, as many as 250,000 holders of broadcast receiving licences in this country (about 3 per cent. of the total) were subscribers to relay

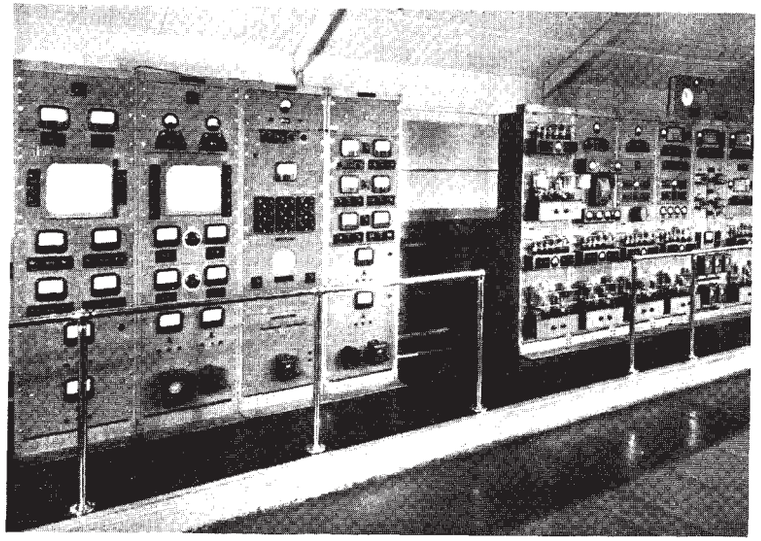
An Electrophone advertisement ("£5 a Year !—Direct from the Footlights")

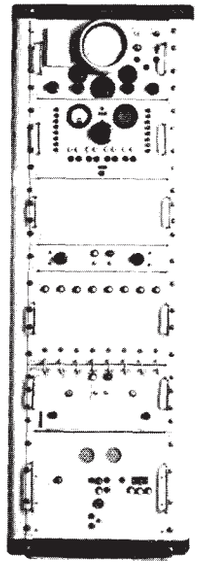
exchanges. It was to be expected, therefore, that consideration should be given to the possibilities of distributing television programmes also by wire. In hotels and large blocks of flats, it is particularly difficult to arrange for satisfactory reception without using many roof aerials, which in large numbers are both costly and unsightly; instead, one aerial, of special construction and in a carefully selected position to suit the local reception conditions, and usually with an amplifier, is used to feed the received signals over a cable to which a large number of ordinary television radio receivers in the building are connected. Such communal television aerial systems were introduced at an early stage, but it was not until 1950 that any systems were licensed for television wire broadcasting.

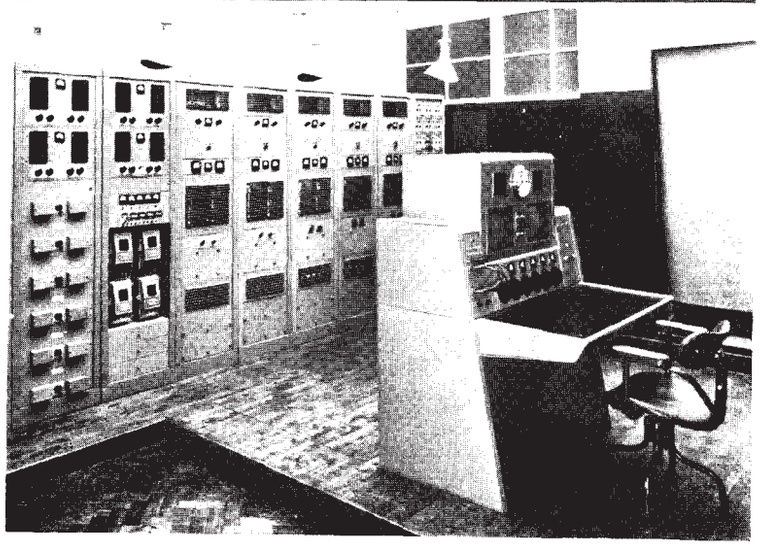
In comparison with wire broadcasting of sound programmes, the technical problems of television wire broadcasting are more difficult, but the benefits to the user can be greater. The design of any wire broadcasting system aims at reducing the cost of reception by simplifying the subscriber's equipment. This cannot be done without added complexity of the distribution wire network and of the sending equipment. For a large enough number of subscribers, however, the cost of these items is small compared with the cost of all the subscribers' receivers. Television wire broadcasting cannot achieve the degree of simplification in the subscriber's apparatus which is possible in sound systems, but the saving, though proportionately smaller, may be large enough to be attractive and still leave a margin for free maintenance and replacement service. This service is a special attraction for television receivers, which must include expensive cathode-ray tubes.

Television wire broadcasting offers special opportunities of providing satisfactory service in places where direct radio reception would be difficult and costly. For this reason, there might eventually be a greater demand for television than for sound wire broadcasting. Television is more vulnerable to various forms of interference, especially to interference from the ignition systems of motor cars. At the wavelengths suitable for radio transmission of television signals, reflections from buildings, hills and many other objects can cause the received picture to fluctuate in brightness or to be marred by "ghost images" or other forms of interference and distortion.

Even where these difficulties are unimportant (as in fairly flat rural areas, for example), the range at which reception is reliable is still limited to the radius at which there is a "line of sight" path between the transmitting and receiving aerials; with ordinary receiving aerials at roof heights, therefore, this range is little more than the horizon as seen from the transmitting aerial. Thus, both inside and outside the "normal service area" of a television radio broadcasting transmitter, there are to be found places where good reception is possible only by using elaborate aerials mounted in positions which are not likely to be accessible to the individual user. In such places, a wire broadcasting system can ensure a far better television service than is available to the







(above) **Post Office experimental 8-channel wire broadcasting transmitter (sound)**

(top left) **Wire broadcasting installation at Hayes (television and sound)**—*By courtesy, E.M.I.*

(bottom left) **Wire broadcasting installation at Gloucester (television and sound)**—*By courtesy, Link Sound & Vision, Ltd.*

viewer with his own aerial and radio receiver, because the receiving aerial, shared between many viewers, can be constructed and erected with relatively little regard to cost.

As with sound systems, the form of the Post Office licence ensures that the conduct of television wire broadcasting systems shall conform to the policy applied to broadcasting generally: the licences are issued subject to technical conditions designed to ensure that wire broadcasting systems shall not be dangerous or interfere with the working of other services. Recommended standards of performance agreed with the relay industry are associated with the licences. The standards are framed in such a way as to foster the installation of systems which, while making the best possible use of reception conditions current at the start of the service, could be modified at reasonable cost to take advantage of future improvements in reception conditions.

The various systems that have been proposed or developed for television wire broadcasting differ in many details, especially in the extent to which the subscriber's receiver is simplified. Use of the received radio broadcast frequency for distribution is limited mainly to communal aerial systems for use within single buildings; using special cable, however, this method might be satisfactory for ranges up to about 500 yards without intermediate amplifiers. Most other systems use carrier frequencies between 5 Mc. s. and 15 Mc. s. Some transmit both sidebands; others use vestigial sideband transmission.

At the lower carrier frequencies (5 Mc. s. to 10 Mc. s.), cable can be used similar to that which has become popular for sound wire broadcasting systems—a 2-pair star-quad cable, polythene insulated and sheathed; for television, however, the cable must be screened to ensure stable performance, reduce radiation and avoid interference with the system.

Some systems are now taking the form of an unscreened quad cable and a screened quad cable run together; one pair of the screened cable carries a television programme with its own sound on the same pair, and an additional sound programme is available on each of the other three pairs. Others provide for five additional sound programmes which are transmitted on carriers of lower frequency than the vision carrier.

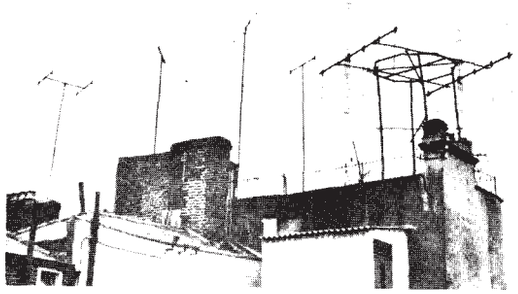
If the vision signal is distributed in the form in which it is broadcast by the B.B.C. and merely changed in frequency, the economy in the receiver results from the stronger signal and the absence of interference. In some systems, however, by sending special synchronising signals or by sending "saw-tooth" signals which produce the "raster" (scanning pattern) on the subscribers' screens, still further economies are achieved in the synchronising and scanning parts of the subscribers' receivers.

The arrangements for feeding the signal into the distribution system may vary according to reception conditions at available receiving sites. If reception is generally difficult, there might be a remote receiver linked to the central distribution station by cable or by a radio link. An installation at Gloucester has its television receiving mast on a high hill some three miles outside the town, with the receiver housed at the foot of the mast. The mast also carries the aerial of a transmitter, which operates on a frequency of about 2,000 Mc. s. and relays the received television signal to the central distribution station in the town. Here the signal is again changed to the lower frequency used for distribution to subscribers. Besides the television sound, three other sound programmes are distributed, all sound programmes being received on the hill and sent over Post Office lines to the central station.

The use of a line link instead of the radio link for the vision signals would reduce the amount of attention required at the remote receiving station and would bring other advantages. It has been estimated that ordinary Post Office local telephone cables could be used for such links up to about eight miles and show a saving over radio links. A simplified version of the equipment used for similar purposes in connection with television outside broadcasts is being made for trial in an experimental link. There might also be limited economic use for links using special cable to cover distances between about five and fifteen miles.

The future of television wire broadcasting is closely linked with that of sound wire broadcasting, not only because they can share the same cables and the same subscribers' receivers, but because the only way in which radio broadcasting can at present be developed technically (by using v.h.f. transmission) will lead to similar conditions of radio reception for both sound and television services.

It would be rash to predict how far or in what way wire broadcasting services are likely to grow, but, as this survey of a complicated and extensive subject has shown, there is at any rate ample scope for technical development.



Roof aerials in large numbers are both costly and unsightly
Photo, by courtesy of Rediffusion

The Training of War Blinded Telephonists

by J. W. Tatum, Brighton Telephone Area

IT ALL STARTED BACK IN 1915, WHEN THE first blinded soldiers began to return from the front. The late Sir Arthur Pearson, Bt., who himself was blind, determined to do his utmost to enable these men to "learn to be blind". The first four men were received in a small hostel in Bayswater Road, London, in February, 1915. The work grew rapidly, and in March the organisation took over St. Dunstan's, a large house on the edge of Regent's Park. To-day, there are many "St. Dunstan's" houses and centres, and blinded men and women are not only trained but are helped with welfare work throughout their lives. Since 1915, some 5,000 men and women have come under the care of St. Dunstan's. More than 250 of them have been trained as P.B.X. operators, several not only being blind but also having only one hand; one man is both blind and handless. The Post Office has been able to help considerably with this work. The main centre for training in telephony is at St. Dunstan's, at Ovingdean, in Sussex, a few miles east of Brighton.

The first task is to restore self-confidence and develop the art of "seeing" through the senses of touch and hearing. By skilled and patient guidance, in some of which blind instructors are employed, the mental blackness of early blindness gradually gives way to a visualised world built by the imagination out of previous knowledge of form and texture. The blind man learns how to walk about alone, to shave, take care of his appearance, do woodwork, play games and in general lead a normal, active life. This restoration of self-confidence and development of manual dexterity and touch sensitivity takes up to twelve months or so. During this time, the blind man learns to touch-typewrite, read Braille and operate a Braille typewriter. Meanwhile, the St. Dunstan's staff study his individual ability and character and form some idea of what occupation will suit him best, so that he can be helped to decide a career. There is inevitably a limited number of occupations for which large numbers of blind persons can be trained with a good prospect of effective employment. Among these are physiotherapy, capstan lathe operating, small shop management and P.B.X. operating.

Telephone operating by blind men is limited to P.B.X. work. The main reasons for this are that signals that can be distinguished by touch and sound are required in place of visual signalling; less reference to written information is required, and much of it can therefore be memorised, and no ticket work is needed. The first two of these also limit the blind operator to the single-position P.B.X.

At Ovingdean all learners are taught to operate "5 — 20", "10 — 30" and "10 — 50" switchboards, which are of standard Post Office pattern except for modification to the supervisory indicators. There are also facilities for training on cordless P.B.X.s, but this is given only if specifically required.

The usual arrangement of practice and control positions is followed, as in Post Office Telephonist School training. The instructor originates calls from her control switchboard to the learner's practice position, and the learner, in completing the connection, calls on the control position, the instructor thus acting the part of both caller and

Fig. 1. Practice and control positions

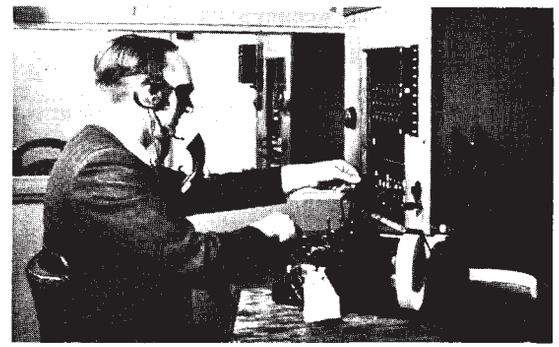


Fig. 2. Identifying the calling indicator by touch. (This learner, Mr. J. Lewis, now operates a Government Laboratory P.B.X.)—*Associated Press photo.*

called and the learner fulfilling the normal operator's function. The general arrangement is shown in Figure 1, where the blind man is operating a "10 — 30" position and the "control" (unstaffed) is visible beyond a sliding glass panel. The blind pupil requires more individual attention than a sighted one, and one instructor can handle only one at a time.

Again, the blind person requires a longer period of training that the sighted person. This is not just a question of taking longer to acquire new skills; there is also the fact that during the initial practice the mental concentration required of the sightless is very considerable, and until the training is well advanced only two periods of 40 minutes each, with a complete relaxation from telephone work for the rest of the day, are permissible if a sense of strain that will defeat the purpose is to be avoided. Even so, it is possible to turn out a fully trained P.B.X. operator in about six months, which, considering the inherent difficulties and limited periods of actual training, appears a not inconsiderable achievement.

The instructors are all Post Office telephonists from Brighton or another nearby exchange. A vacancy for an instructor is advertised locally and applicants and their probable suitability for this work are reported on by the Telephone Manager to St. Dunstan's; but the final selection is made by St. Dunstan's alone, as a result of interviews. While at St. Dunstan's, instructors remain on the Post Office pay roll, St. Dunstan's reimbursing the Post Office.

Among the qualities desirable for this work, a pleasant, friendly voice is especially important to persons who learn to know one largely through the voice. To this must be added the other qualities essential to any good instructor: patience, tact and understanding. Occasionally a mistake is made, and it becomes evident that a man will not qualify as a telephonist. The sooner he is told the better—not a very easy task when dealing with a man so handicapped, who is trying his best. The instructor must have the character to act firmly and yet in such a manner as to cause least damage to the processes of mental rehabilitation.

Until recently there were three instructors, but now that the worst of the last war's aftermath has been dealt with, the number has been reduced to two. Each instructor can deal with about four learners concurrently, and can turn out about eight a year.

Post Office standard one-position P.B.X. switchboards use indicators and not lamp signalling. St. Dunstan's operators are taught to listen, with the heightened hearing that the blind develop, for the small sound made by the dropping of the indicator. Reliance on any more audible alarm (for example, a buzzer) is not permitted, so avoiding possible complaints of disturbance to others.

When he hears an indicator drop, the operator runs his fingers across them from left to right, as shown in Figure 2. By using several fingers, he can hunt over several strips of indicators simultaneously. In the picture it can be seen that his middle finger has stopped on an operated extension. Below the calling indicators are, of course, the corresponding sets of jacks on which to call or answer the extensions or exchange. In the picture, the operator is taking the plug out preparatory to running his fingers along to find the jack corresponding to the calling extension.

The only feature in which the blind operator's P.B.X. differs from the normal one is in the adaptation of the cord supervisory signals. These, being horizontal, are under glass to prevent the entry of foreign matter. It is therefore not possible for the blind operator to feel them as he can the calling signals. The problem, therefore, was to translate the position of the indicator into a touch-responsive mechanism, without doing away with the glass protection.

This is achieved by means of a small marker closely fitted in a circular hole cut in the centre of a transparent plate, which replaces the plate normally protecting the supervisory signal. When the indicator is in the operated position, it pushes the marker up as shown in Figure 3, and the

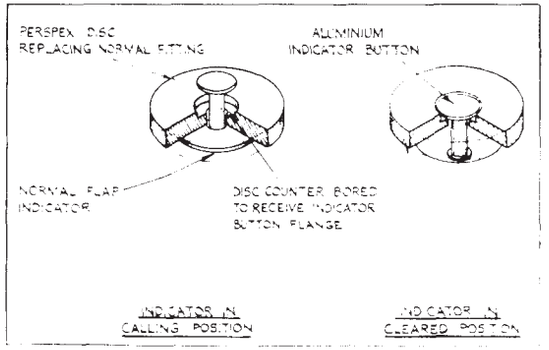


Fig. 3. The touch call-indicator

operator can then feel it. In the non-operated position, the top of the marker is flush with the glass covering. The supervisories remaining operated, the markers are up all the time that connection is established between caller and called, but replacement of a receiver causes the supervisory signal to restore to normal, the marker drops back and gives the indication to the telephonist. These markers are now a standard item of Post Office stores. Not only are they used in this country, but on occasions they have been supplied to St. Dunstan's, so that a blind man can take a stock with him to a job overseas.

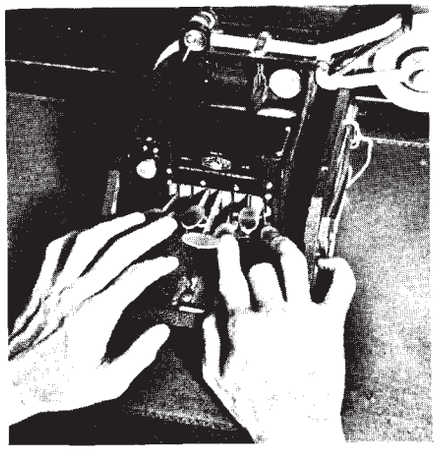
It may be wondered how the blind man is to remember messages left with the P.B.X. operator. The sighted person can jot them down on a memo. pad: so, in effect, can the St. Dunstaner. He is taught a form of brief-hand by which most words can be expressed in two or three letters. A Braille tape typewriter is provided, illustrated in Figure 4. It will be seen that there are only seven keys: a long one in the centre and three on each side. The keys are arranged so that if necessary they can be operated by one hand. Braille characters consist of various combinations of six dots. These are punched by the six shorter keys on to paper tape, the centre key being a spacer. With this instrument the operator, using the brief-hand, can quickly record messages on the tape.

During the first few lessons, the instructor sits with the learner on the practice position and, by explanation and help in guiding his hands over the switchboard, enables him to visualise it and so to become familiar with the functions of the different items of equipment. The pupil then learns and memorises the details of the various extension users and exchange lines, which are, in fact, a replica of the live P.B.X. at St. Dunstan's, Ovingdean. The extension users are therefore mostly familiar to him and the task of memorising them is relatively simple. He then starts practice with calls coming in to the extensions. When he has mastered these and acquired some dexterity, he goes on to deal with calls going out to the public exchange. In this connection, he learns how to dial and is assisted by having notches cut in the edge of the dial plate opposite digits 4 and 7. A dial speed tester is fitted at the top of the control position, and as this is wired to the practice position dial, the instructor can check that dialling has been performed correctly. After some four to five months of perseverance and patience by both pupil and instructor, the pupil can be promoted to live traffic by being put on to the Ovingdean P.B.X.

At this stage it becomes necessary to look for a job for the trained telephonist. The Telephone Placement Officer—a former Post Office telephonist, who was one of those lent to St. Dunstan's as an instructor—gets in touch with the Telephone Manager for the man's home area and obtains details of suitable P.B.X.s in that locality. She then canvasses the renters and when a likely employer has been found a preliminary visit is arranged for the trained man, accompanied by the Placement Officer. If the interview is mutually satisfactory, details are obtained of the P.B.X. extension users and the general organisation of the firm or department; also, particulars of the outside numbers more frequently called. When he gets back to Ovingdean, the trained telephonist incorporates this information in a Braille Directory and memorises it. After a fortnight spent on practice traffic made to simulate the traffic of the P.B.X., and a few days at the P.B.X. itself, the blind telephonist starts his new job, accompanied for the first few days by the Placement Officer.

That so much can be achieved is wonderful enough, but I should like to describe briefly a further development—the provision of a P.B.X. for the blind and handless man to whom I have already referred.

It was in 1943 that Sir Ian Fraser, C.B.E., M.P., Chairman of St. Dunstan's, sought the aid of the Post Office in solving the apparently insoluble problem of finding a useful occupation for a blind and handless man. Preliminary consideration suggested a cordless P.A.B.X., and eventually, after some two and a half years of research and experiment, the final product shown in Figure 5



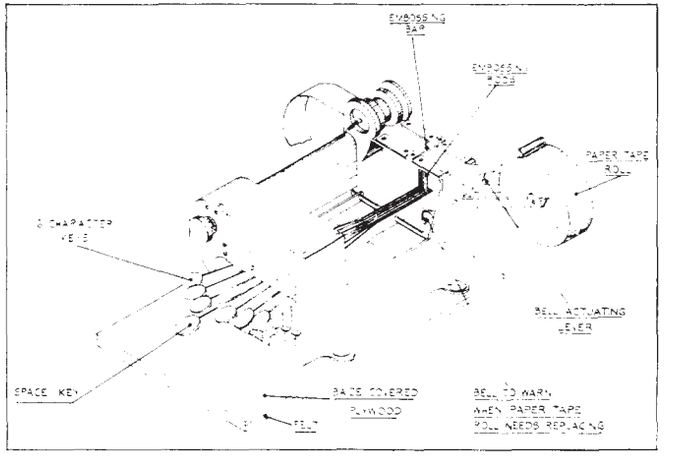


Fig. 4. Braille tape typewriter used by the sightless P.B.X. telephonist

was evolved. This was largely the work of Mr. J. H. Combridge, of the Post Office Engineering Department, with devices developed by Mr. P. B. Nye, who is in charge of St. Dunstan's Research Department. I am indebted to Mr. Combridge and to the editors of the *Post Office Electrical Engineers' Journal* for the following details, which are mainly abridged from a full description published in the *P.O.E.E.J.* for July, 1948.

The mechanical arrangement of the keyboard is illustrated in Figure 5. The basic idea is to use a metal rod, attached to the operator's arm, to operate a series of plunger keys. The rod is guided to the keys by holes cut in the centre of guide slots. The four rows of jacks provide the following facilities:

Top row—Speak keys for miscellaneous circuits.

Second row—Digit keys connected to a key sender.

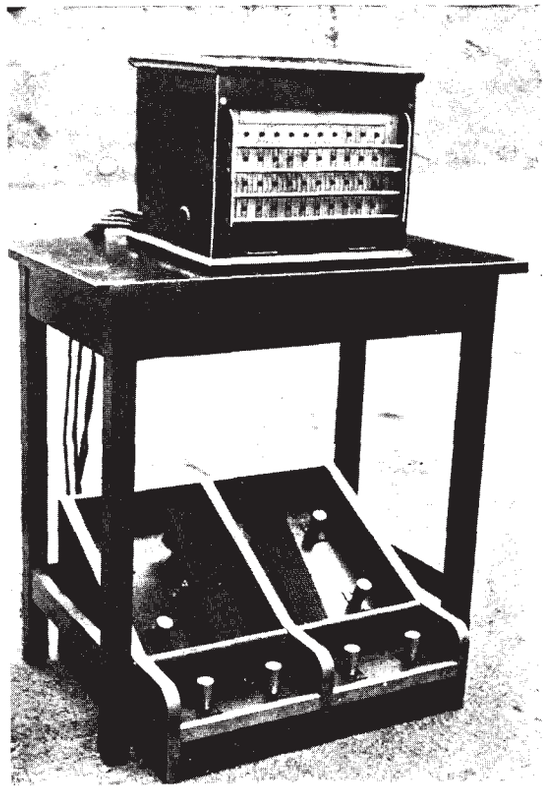
Third row—Speak keys for exchange lines.

Bottom row—Digit keys for selecting extensions.

In front of and slightly below each row of jacks is a free standing tone bar, which helps to guide the operator's rod. Foot pedals are used to perform various "common" functions. Following is a simple description of the operating procedure:—

When an incoming call is received, a low-toned buzzer sounds continuously. The operator presses a foot pedal to silence this and, placing his rod on the tone bar of the third row, slides it along

Fig. 5. Cordless board evolved for operation by sightless and handless telephonists



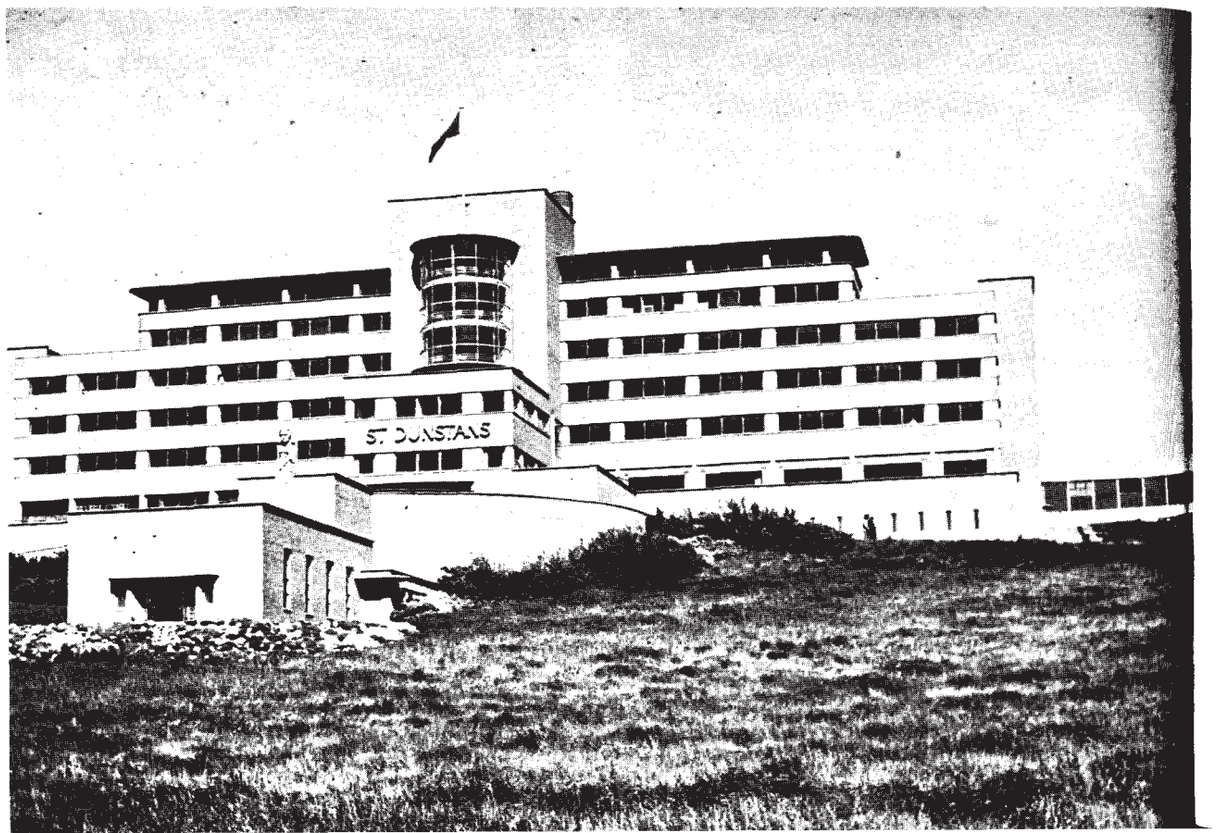
the bar with the end in contact with the key plates, until he comes to one which is distinguished by the sounding of a high-toned, interrupted buzz. On pushing with his rod the key within the jack in the centre of the guide channel, the operator connects his instrument to the calling line and, after ascertaining the extension wanted, keys out the required two digits on the bottom row. Supervisory conditions are provided by tones from the key plates.

Outgoing exchange calls can normally be dialled directly by the extension users, but if the operator's assistance is required, dialling of the appropriate code causes the buzzer to sound interruptedly. In this case, the operator searches along the top row of key plates and answers as before. On learning that an exchange call is required, he presses a foot pedal, which puts a tone on the key plates of all engaged exchange lines and thus enables him to select a free one. When the dialling tone has been received, the operation of another pedal connects the key sender, so that the call may be keyed out.

A board of this type, with a capacity of five exchange lines and 24 extensions, is in use in one of the St. Dunstan's buildings, where it is regularly operated by a blind, handless man. So in some two and a half years equipment was devised enabling a man with no sight and no hands to operate a "5 – 24" P.A.B.X. switchboard. Who would have supposed a few years ago that such an achievement was possible?

In conclusion I should like, in addition to the acknowledgments already made, to thank all those, both in St. Dunstan's and the Post Office, who have helped me in preparing this article—not least the St. Dunstaners themselves, whom it is not possible to visit and talk to without coming away humbled yet exhilarated by their magnificence of spirit.

St. Dunstan's, Ovingdean, Sussex *Photo. by "Topical" Press Agency*



Relief of Overload Conditions at a Large Manual Group Centre Exchange

by E. L. Perkins,
Liverpool Telephone Area

AS A RESULT OF THE WAR AND THE CONDITIONS arising in the post-war years, which have involved deferment of conversions to automatic working, many of our remaining manual exchanges are in a difficult position, and it has been necessary to adopt all kinds of expedients at these exchanges to cater for growing traffic, to maintain a reasonable standard of service and to meet new subscribers' development. This article describes the rather unusual methods adopted at the Warrington manual group centre, which may be of general interest and possibly have some application elsewhere.

Historical Background

During the war there was great expansion of industrial activity in the Warrington district. The calling rate, originating and incoming, increased by over 50 per cent. and the exchange had to be extended to the maximum capacity of the switchroom (42 positions) to provide for the increased traffic (Diagram 1). Although there was a temporary decline in traffic after the war, business and industry developed rapidly again and 600 new lines had been added by the middle of 1947, raising the total to 2,600 working lines. In addition, the trunk traffic handled at the exchange had grown to about 1,000 calls daily and a manual board service was provided for 7 small automatic exchanges. The surrounding exchanges were also developing rapidly—one of the automatic exchanges was extended to the full 800 lines and will shortly be extended to 1,600 lines. Thus, the Warrington exchange soon became fully loaded.

Planning for the provision of a new automatic exchange with capacity for 5,900 lines and an auto-manual switchboard of 44 positions was in its initial stages, but relief could not be expected in this way for a number of years. It was therefore necessary to consider other possibilities. Measures such as area correction or the transfer of traffic from unit automatic exchanges and dependent minor exchanges to other centres were not practicable. It was decided, therefore, to provide a manual relief exchange to handle trunk calls.

First Relief Scheme

No suitable accommodation near to the present exchange could be found for the relief switchboard, but, fortunately, special arrangements made during the war came to our aid, for we were able to use, in its existing situation, a large private branch exchange of C.B. type originally provided for the United States Army Air Force at a station about three miles from Warrington.

The 25-position switchboard (see Diagram 2) had, of course, to be modified to provide for trunk and auto-manual service, but this work was completed far more quickly than a new exchange could have been provided. Outgoing trunk service only was given by the relief exchange, incoming trunk service remaining at the main exchange to minimise double handling of calls.

In view of the isolated position of the relief exchange, staffing presented several problems. Operators had to travel daily from Warrington and the only suitable buses left Warrington at 8.0 a.m. with a return from the exchange at 5.10 p.m. It was necessary to make arrangements with the bus company to ensure that the increase in passengers at these times could be carried, and special duties had to be arranged with allowance for travelling.

The traffic which would have been handled by the relief exchange at night and on Sunday was scarcely sufficient to warrant the provision of separate staffing at these times and, because of the

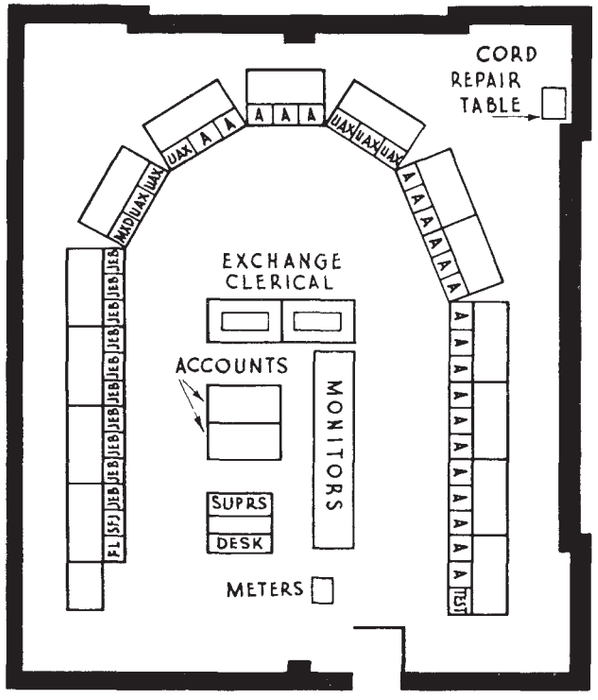


Diagram 1
Warrington C.B. Manual Exchange, 1947

longer daily tour of duty with the allowance for travelling, it was convenient to exclude Saturdays also. The trunk exchange was therefore staffed from 8.30 a.m. to 4.45 p.m., Monday to Friday only. Switches were provided in the main trunk circuits to Manchester, so that these circuits could be diverted from main to relief exchange as desired. Special operating procedure had to be devised for this change-over, which in effect constituted an exchange transfer twice daily.

Second Relief Scheme

The traffic continued to grow and the first relief scheme could do no more than provide a temporary solution. There were not sufficient pairs in the cables between Warrington and the relief exchange to accommodate additional trunk circuits together with the junctions which would have been required to enable the relief exchange to function as the parent auto-manual switchboard for the unit automatic exchanges dependent on Warrington. The provision of a new cable would have been costly and it would have had no permanent use when Warrington was ultimately converted to automatic working. A second relief scheme was therefore planned.

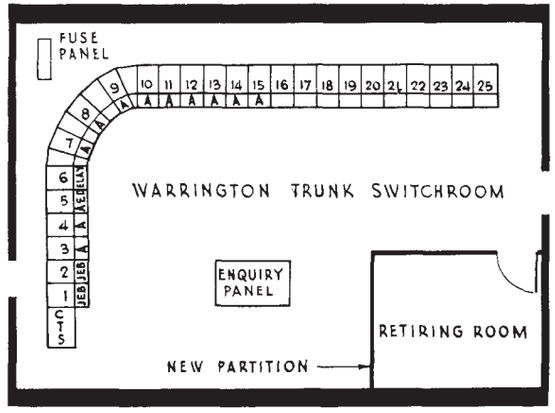
This scheme took the form of providing a new manual exchange of C.B. No. 10 type in the Empire Hall Building, which is fairly near the main exchange and which had been used for the Telephone Manager's Section Stock Stores; the Section Stock was transferred to a garage acquired from the Warrington Corporation Transport Department. Despite some delays due to shortage of materials, the minor building alterations to provide adequate space, lighting and welfare facilities for the new exchange were sufficiently advanced by October, 1950, for installation to commence. Construction of the new exchange was pressed forward with all possible speed and by April, 1951, the relief trunk and auto-manual exchange was ready for service.

Monitors Panel

Twenty-five positions were installed in the new exchange, arranged in two suites, as shown in Diagram 3, so that if necessary they could each be increased in a straight line. A two-position monitors' panel was provided for enquiries, route and rate quoting, etc.

Three ancillary appearances of calling equipments were provided and the arrangement of

Diagram 2
Warrington Trunk Relief Exchange



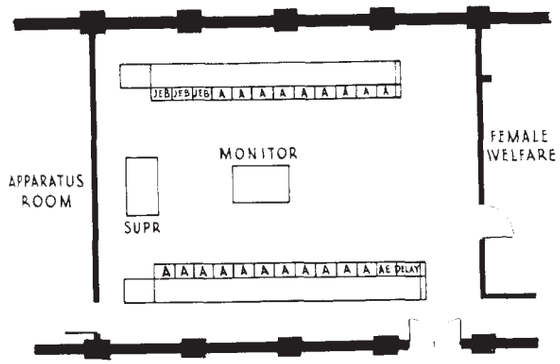


Diagram 3
The Empire Hall Annexe

incoming circuits provides for one suite being used primarily as a separate trunk suite for the manual exchanges and the other as a joint trunk suite for the dependent automatic exchanges. During the less busy periods, an ancillary appearance of the calling signals provides for concentration of all work on 6 positions on one suite.

Record circuits are provided from Warrington and the large manual exchanges in the group direct to the relief exchange and provision has been made for trunk subscribers' lines from the larger private branch exchanges.

Outgoing Circuits

As in the original relief scheme, the trunk service provided from the new relief switchboard is outgoing only. Direct junctions are being provided from the main exchange to the dependent automatic exchanges, to minimise double handling of calls to these exchanges.

No switching of trunk circuits to the main exchange at night is provided in this scheme, as the closing down of the relief exchange would also have necessitated switching some of the junctions serving the dependent automatic exchanges and involved the reservation of switchboard capacity at the main exchange. Furthermore, the additional traffic from the automatic exchanges now handled by the relief exchange justifies the provision of night and Sunday staffing.

Junction and toll circuits are provided to Manchester and Liverpool, to make the relief exchange as far as possible independent of the main exchange.

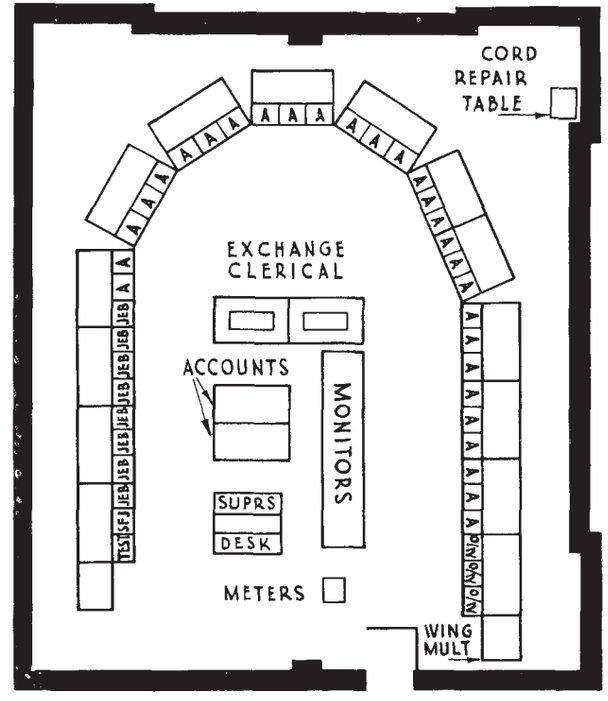
Traffic from Dependent Automatic Exchanges to Warrington Subscribers

A considerable proportion of the originating traffic from the automatic exchanges is to Warrington subscribers. Double handling of these calls could have been avoided by providing dialling-out to the main exchange, but when this was examined, it was found that the position savings at the main exchange were reduced considerably. Routing via the 'O' level and by order-wire junctions to the main exchange was therefore adopted.

Rearrangements at Warrington Main Exchange

To secure the maximum benefit from the relief to the Warrington main exchange, it was essential that as few positions as possible should be used to handle incoming traffic arising from the transfer of trunk and auto-manual service to the relief exchange. Straightforward junction working would have been the most economical in the use

Diagram 4
Final layout of manual exchange



of positions, but the necessary equipment could not be obtained in time. Order-wire working was therefore adopted. The final arrangement of positions is shown in Diagram 4.

Opening Arrangements

The opening of the new exchange involved the transfer of 29 outgoing trunk circuits from the first relief exchange and 106 U.A.X. junctions from the main exchange. To avoid interruption of service, the 'O' level circuits from the dependent automatic exchanges were transferred on a piecemeal basis—a proportion of the outlets were "busied" while the relative circuits were transferred, then service was given on the transferred circuits while a further proportion was cut over. Pre-transfer testing was carried out on 100 per cent. of the circuits involved in the scheme, but in view of the complexity of the automatic exchange rearrangements, the testing was carried out for each exchange in turn, jointly between engineering and traffic staff, just prior to the actual transfer.

Although it is not yet possible to make a final assessment of the result of the relief measures, it is clear that both the local and trunk services have been materially improved and it is estimated that the margins now available will permit the connection of a further 800 subscribers at Warrington, provide for growth of trunk traffic and allow normal development to take place at the dependent automatic exchanges: by this means it is hoped to tide over the next few years, until the new automatic exchange can be provided at Warrington.

A descendant of Wheatstone

Following our editorial "Comment" (May issue) on the subject of Sir Charles Wheatstone, we have heard from Mr. D. Dillon-Shallard, a telephonist at Harrogate. This correspondent points out that Sir Charles (his great-grandfather) was also the inventor of the concertina, of which his family still holds the original model.

Wheatstone's genius was indeed many-sided.

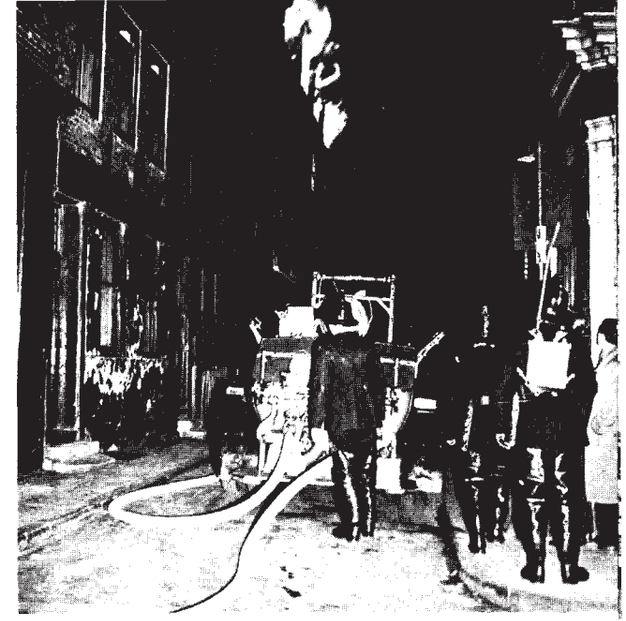
Some Statistics of the Inland Telecommunications Services

	31st March, 1950	31st March, 1951	31st March, 1952
THE TELEPHONE SERVICE AT THE END OF THE YEAR			
Total telephones in service	5,171,500	5,426,100	5,716,200
Exclusive exchange lines	2,924,700	2,966,200	2,999,800
Shared-service connections	214,800	324,800	463,200
Total exchange connections	3,139,500	3,291,000	3,463,000
Call offices	55,900	58,300	60,400
Automatic exchanges	4,091	4,201	4,297
Manual exchanges	1,775	1,666	1,584
Orders on hand for exchange connections	551,600	532,500	482,000
WORK COMPLETED DURING THE YEAR			
New telephones provided	539,600	561,700	603,400
Net. increase in telephones	252,300	254,600	290,100
New exchange connections provided	356,000	390,200	439,000
Net. increase in exchange connections	120,700	151,500	172,000
TRAFFIC	(millions)	(millions)	(millions)
Local telephone calls	2,940	3,076	3,230
Inland telephone trunk calls	235	250	261
Cheap rate telephone trunk calls	49	54	62
Inland telegrams (excluding Railway and Press)	41	41	38
Greetings telegrams	—*	2	6

* *Service restored 20th November, 1950.*

Fire Force Communications

by E. A. Smallwood, Inland Telecommunications Department



(By courtesy, London Fire Brigade—L.C.C.)

THE INTRODUCTION OF THE NATIONAL FIRE Service in 1941 and the centralisation of the control of a number of brigades or stations emphasised the importance of the part communications play in the fire service of this country: nor was this lessened by the subsequent transfer of the fire service to county and municipal authorities in April, 1948. This article describes some of the communication problems that arise in relation to the fire services, and the measures adopted to handle them.

Organisation of a Fire Force

Apart from the London Fire Brigade, the organisation of the county or county-borough fire service follows a fairly clearly defined pattern. At the top are the Council's officers, with general responsibility for the service, the Watch or Fire Committee and the permanent official, the Chief Fire Officer—in Scotland, the Firemaster—with their staffs. Normally, the office housing the Chief Fire Officer and his staff also houses the "Watch Room", a vital part of the means of control by the Chief Fire Officer over the men and equipment under his command. To the Watch Room, which is continuously staffed, come reports of all fires and "incidents" within the force's area, whether the calling out of the appropriate brigade is performed by the Watch Room staff or by Divisional Officers. From the Watch Room go the orders to the various stations to despatch more appliances to the scene of a fire or to move appliances to strategic points in order to cover part of the county divisional area which may have been denuded. In it are the private branch exchange, the siren controls (if any distant stations are called out by the Watch Room staffs), radio transmitting and receiving equipment for maintaining contact with the Divisional Officers' cars, and large-scale maps of the area controlled, on which are plotted the positions of all appliances at any given moment. (See Figures 2 and 4.)

Next in the chain of command comes the Division (Figure 1), under the command of a Divisional Officer. Generally there are up to four divisions in a county authority, each covering for administrative purposes a definite portion of the area and with divisional headquarters usually situated at the largest and most important fire station in the area.

The last unit is the station, where the fire appliances are housed and maintained. The stations of the large towns and the county boroughs will be familiar to everyone; they are normally manned by full-time firemen, although sometimes augmented by part-time staff. Reports of fire calls and the orders from the headquarters Watch Room are passed direct to the station by private wire. Communications are therefore a simple matter. Staffing conditions in the rural areas, however, present problems rarely encountered in the big towns. Clearly a small village, or even two or three adjacent villages, cannot support a full-time fire brigade and can rarely support a part-time brigade in which regular scheduled attendances are performed. Usually the unit consists of part-time men following their normal occupations,

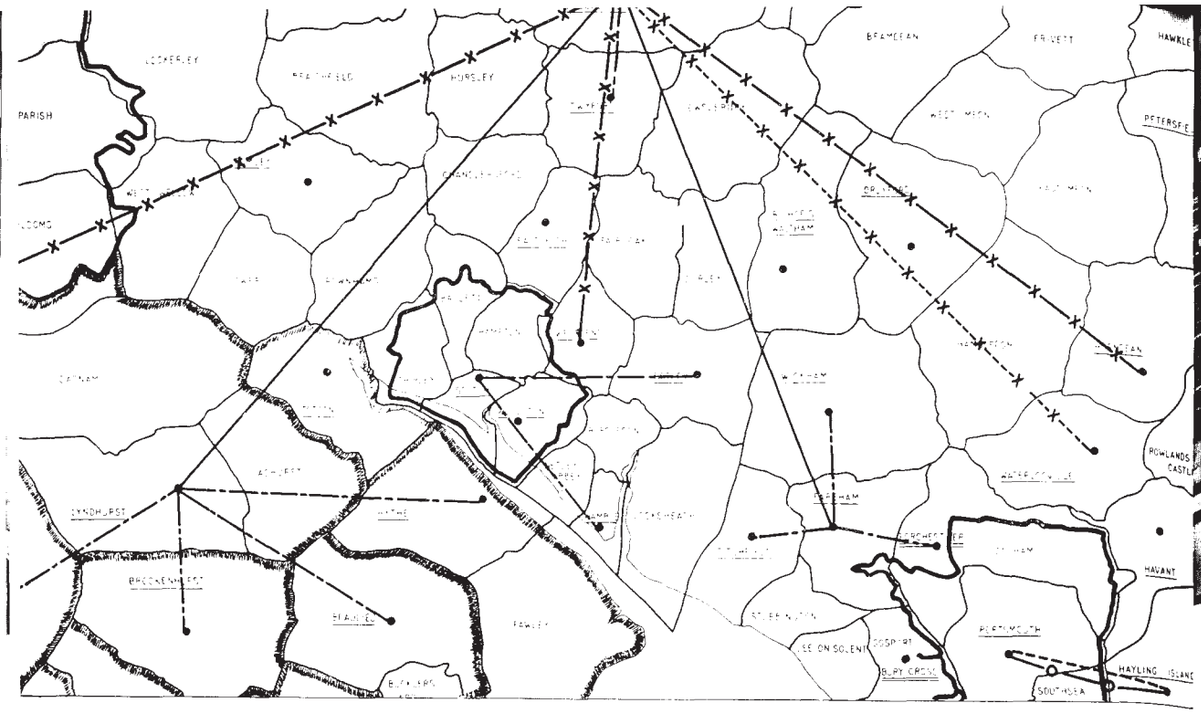


Fig. 1. Layout of a typical division

———Speech private wires
—— ——System "C" remove controls
— — — " " " " in course of provision
—×— " "D" " "
- - × - - " " " " " " " " "
——O——Modified system "A" remote control

Telephone exchanges ... DURLEY
Fire stations ... PORCHESTER
Tel. exch. and fire stations WICKHAM
County or County Borough boundary :
Exchange boundary :

who are prepared to drop that work on hearing the summons—a warning siren operated from the Watch Room—report at the station to learn the location of the fire, and remain under Brigade orders until the incident is over.

Three Phases

This brief outline of a fire force organisation shows that efficient communication between the constituent parts is essential. Fire force communications may be divided into three parts or phases : (a) the connection of the caller reporting the fire to the point designated by the emergency authority to receive such calls, and any necessary relaying of the information to the headquarters Watch Room; (b) means of enabling the report-accepting point to summon the appropriate fire station; (c) the provision of means whereby the officer in charge of apparatus at the scene of the fire may speedily summon additional equipment and men when necessary, and whereby the headquarters Watch Room may speedily carry out any subsequent regrouping of the remaining forces necessitated by the withdrawal of appliances to combat the fire. How are these requirements fulfilled?

In the large towns and the county boroughs, the problem of communications is greatly simplified by the extensive telephone cable network available and by the simple fire force organisation. Most of the big towns and county boroughs are served by automatic telephone systems, which, with their associated auto-manual switchboards, provide the 999 emergency dialling service.* The connection of the caller to the fire force switchroom is therefore speedy and simple. Even where the telephone system is still manual and the 999 service is therefore not available, connection of the caller to the Watch Room, via the public exchange, follows the same lines as when the 999 service is available. Usually special circuits are provided from the public exchange multiple direct to the Watch Room private branch exchange; the Watch Room officer receiving the report calls out the appropriate station or stations over a private-wire circuit. Simplicity and speed are therefore assured.

* *Fully dealt with in an earlier Journal article in May, 1949*

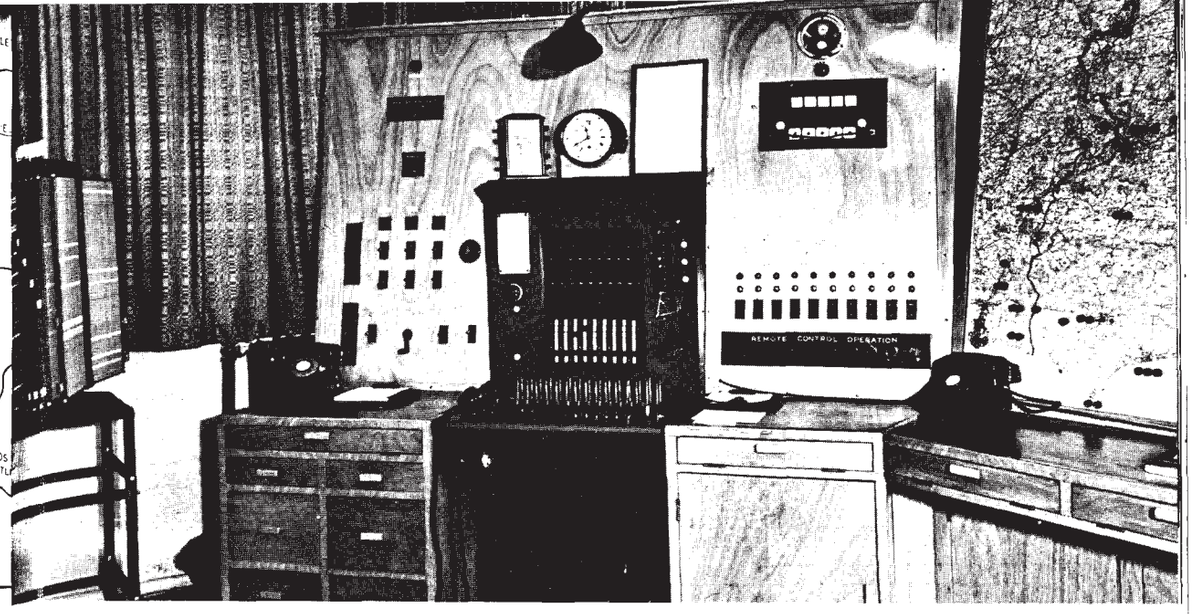


Fig. 2. A typical Watch Room (Worthing). To the right of the telephone switchboard are the control keys and supervisory lamps of the siren remote control, each labelled with the name of the station concerned: on the left are the call bell, siren and miscellaneous switches for the running of the station. At the right of the picture is the plotting map *(By courtesy, West Sussex Fire Brigade)*

It often happens that the areas served by a director or non-director exchange system do not coincide with those of the county borough authorities. Where this occurs, it will seldom be possible for the public exchange operator receiving the emergency call to discriminate between those calls that should be connected to the county borough and those that should be connected to the county authorities. The usual practice is that all calls from the multi-exchange system should be connected to the county borough authority, since they will normally deal with the vast majority of emergency calls originating from within the telephone system, and that those proper to the county authority should be relayed by the borough authority to the appropriate point by private wire or radio link.

In the country districts, the widespread provision of the 999 service at unit automatic exchanges serving the rural areas has solved to a large extent the problem of speedily connecting the caller reporting the fire to the appropriate report-accepting point, since the public exchange operator who answers the emergency call has readily available information enabling her to distinguish the fire station to which calls from that exchange should be connected. Where the caller reporting a fire is speaking from a telephone on a small manual exchange, the exchange operator also has the necessary information available; in some manual exchanges the exchange operator accepts the report of the fire and operates the siren. This point is dealt with later in this article.

Phase Two

When the problem of summoning the appropriate fire station is considered, serious difficulties often arise. The report-accepting point—the county Watch Room, or the Divisional Office—must necessarily be able to call out the firemen at the appropriate station as speedily as possible. Where this station is manned by "retained" firemen—men following their normal occupation and attending the station only for practice drills and on the occasion of fires—some means must be provided to summon them with the utmost speed and to advise them of the location of the fire.

To afford these facilities, the Post Office Engineering Department, at the request of the Home Office, has developed a number of ingenious "remote control" systems, in which operation of the appropriate key in the Watch Room or the Divisional Office actuates a siren at the station, thus summoning the retained men. As there are obvious objections to the sounding of sirens at night, call bells, operated by remote control in the

INITIAL CALL

Where received	Time received	Time received at Hampshire Fire Control	Text of Message
Aldershot (Military) Aldershot	1915 1917	1919	From ex Tele : From Army Fire Service, fire at Command workshops, P.E. sent.

FIRST ATTENDANCE

Appliances sent	Time left Station	Time arrived at fire	Distance to fire	Officer in charge of appliance: Rank and Name	Officer in charge of appliance: Whole- or part-time	Predetermined first attendance: First Attendance (1)	Predetermined first attendance: Next nearest pumps (2)	Predetermined first attendance: Nearest special appliance (excluding first attendance)
P.E. Military (W)	1915	1917	1¼ miles	Staff Sergt. Taylor	W.T.	P.E. (Military)	P. Farnborough	WR.T. Aldershot
Pump Aldershot (W)	1917	1919	1¼ miles	L. FM. Gibbons	W.T.	Pump Aldershot	P. Farnborough P. Farnham P. Hartley Wintney	P.E. Farnham P.E. Camberley P.E. Alton
P.E. Aldershot (M)	1919	1924*	1½ miles	L.FM. Rixon	P.T.	P.E. Aldershot	P. Odiham	

* Note.—P.E. Aldershot redirected from Field Stores after attending almost simultaneous call. (The Field Stores are in close proximity to Command Workshops.)

ASSISTANCE

Where sent (Station or Control)	Time received	Text of Message	Where sent	Time received	Text of Message
Aldershot	1920	By ex Tele : from Command Workshops, make pumps 3	Hampshire Fire Control	2030	By ex Tele : from D.C.O. Bowles. Now in charge at Command Workshops, 3 pumps for relay, 3,000 ft. x 3½ in. R. L. Hose and 10 Tilley lamps required. To report to W. Gate, Ordnance Road, Aldershot, contact number : Aldershot 380, ext. 0464
Aldershot and Hampshire Fire Control	1922	By ex Tele : from L. FM. Gibbons at Command Workshops, make pumps 8			
			Hampshire Fire Control	2114	From D.C.O. Bowles ; fire surrounded, 15 jets in use from hydrants, open water, static water and 3 pumps in relay from Canal, second 3 pump relay being brought into operation from Canal
Aldershot	1947	By ex. Tele : from Command Workshops, make pumps 10			

REINFORCING MOVES

Text of Message	Where sent	Time received
From D.C.O. : stop for Command W Shops, a range of steel framed buildings consisting of corrugated iron walls, timber, glass and corrugated iron roof, of five bays about 420 ft. · 220 ft., 3 bays of building and contents severely damaged by fire, roof of 2 bays slightly damaged by fire and contents by fire and water	Hampshire Fire Control	2215

Number of appliances available in Hampshire at the time of the call	Appliances ordered by Hampshire Fire Control: Time requested	From where requested and type	Where sent	Remarks
Pumps 25 P.Es. 13 T.T.L. 1 WR.Ts. 21	1929	M. Basingstoke (M)	Aldershot	Sent on to fire from Aldershot
	1931	M. Alton (P)	Aldershot	Sent on to fire from Aldershot
	1935	P.E. Alton (P)	Aldershot	Sent on to fire from Aldershot
	1937	M. Alresford (P)	Alton	Sent on to fire via Aldershot with 3½ in. hose
	1948	M. Crowthorne (Berkshire) (P)	Hartley Wintney	Sent on to fire from Hartley Wintney
	1950	WR.T. Farnham (Surrey) (P)	Fire	Ordered to stand by
	2000	WR.T. Winchester (M)	Alton	
	2034	M. Bracknell (Berkshire) (P)	Hartley Wintney	
	2100	WR.T. Winchester (M)	Aldershot	This appliance was standing by at Alton and moved up

M. Major Pump (P) Part-time Crew
P.E. Pump Escape (M) Part-time and Whole-time Crew
WR.T. Water Tender (W) Whole-time Crew

Fig. 3. Extract from the record of calls and moves made in connection with a fire at Aldershot Barracks

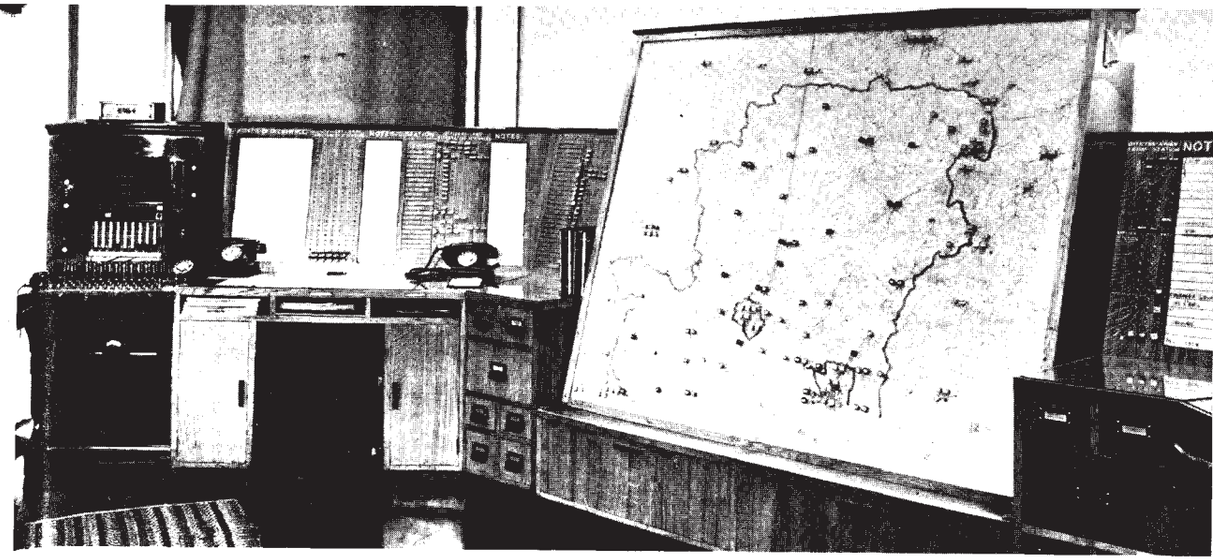


Fig. 4. Watch Room at Winchester. From left to right: telephone switchboard; panel showing locations of fires; coloured pegs of various shapes, denoting particular fire-service officers and types of appliances; panel showing whereabouts of senior officers and reserve appliances, plotting map; panel showing officers on leave, appliances under repair, etc. *(By courtesy, West Sussex Fire Brigade)*

same way as the siren, are often fitted in the retained firemen's houses; a time-switch is included in the circuit to render the siren inoperative during "silent" hours. For convenience in dealing with remote-control systems, the report-accepting point at which the control key is pressed is termed the "call-out point" and the end of the circuit at which electrical energy is applied to the siren or call bell circuits is termed the "ring-out point".

An arrangement known as System A is used for the remote control of sirens, without call bells, over a private circuit, where the radial distance between the call-out and ring-out points is less than one mile. Normally a 50-cycle mains supply is required at the call-out point, but a battery-operated system can be supplied where A.C. mains are not available.

System B is used for the remote control of a call bell system, with or without a siren, over a private circuit, where the radial distance between the call-out and ring-out points is less than one mile. A 50-cycle mains supply of either 200-250 or 100-110 volts must be available at both ring-out and call-out points; a frequency of 100 cycles, provided by a frequency changer at the call-out point, is used to control the synchronous motor unit at the ring-out point.

System C is intended for use where the distance between the two points is more than a mile, where a private circuit with either a siren or a call bell system, or both, is to be used. Again, a 50-cycle mains supply of either 200-250 or 100-110 volts is necessary at both points. A fault indicator is provided to show when the private circuit is faulty or whether the mains are disconnected at the distant end, while an "answer back" signal shows when the unit at the ring-out point has operated. The private circuit can be used for speech as well as remote control and can be connected to a telephone or switchboard at either end; signalling must then be by generator ringing.

System D is intended for use where the call-out and ring-out points are more than a mile apart and where control of a siren and a call bell system by the public telephone network is required. The ring-out point apparatus is connected to an ex-directory line serving the part-time station; a 50-cycle mains supply of either 200-250 or 100-110 volts must be available at the ring-out point and a similar supply of 200-250 volts D.C. at the call-out point. This system is used only where the part-time station is served by an automatic exchange. The fire officer at the call-out point makes a call over the public network to the ex-directory number and is connected in the usual manner, two cycles of ringing tone being returned when the connection is established. With this system an "answer back" tone is then returned by the unit at the ring-out point to indicate to the call-out officer that the correct number has been obtained and a "ring back" tone indicates that current is

going out on all the call bell loops. After the siren or call bells have operated, the circuit is available for speech, so that the first retained man reporting for duty can ascertain from the call-out point the location and extent of the fire.

In conditions similar to those in which System D is operated, but where the part-time station is served by a manual exchange, the system is modified. The usual power supplies of 50-cycle, 100-110 or 200-250 volts D.C. are required. The fire officer at the call-out point makes a call over the public telephone network to the ex-directory number and is connected in the usual manner; the public exchange operators will meantime receive normal supervisory signals. While the siren or call bells are sounding, an interrupted low-pitched tone is received; absence of this tone indicates a fault on the line or apparatus. Again, the circuit is available for speech immediately the siren or call bells have finished sounding.

Certain other systems, some extremely ingenious, have been developed by both Post Office and Fire Service staffs, but attention is at the moment concentrated on systems A, B, C, D and the modified D system.

Phase Three

The third and final phase is that in which the Watch Room controls the fire-fighting appliances at the scene of the incident, brings up reinforcements and regroups its remaining forces to cover areas left unguarded; this phase includes provision for any urgent messages which the officer-in-charge at the scene of the fire may wish to pass back to his Watch Room. For this phase, the public telephone network is used, supplemented where necessary by radio links between the Watch Room and Divisional Officers' staff cars.

In order that these vital fire telephone calls shall not suffer any delay in connection—when, for example, the public network is congested—fire officers use the "Urgent Fire Call" facility, a form of emergency call restricted to Fire Service officials. On receiving a call backed with the code words "Urgent Fire Call", the public telephone operator must ensure that the call is completed with the utmost despatch, an existing non-emergency connection being broken down if necessary to allow the emergency call to be set up.

Within the fire authority's boundaries, each establishment, factory, installation or location with an appreciable fire risk has been surveyed, and a set scale of equipment, appliances etc. has been scheduled for turning out on receipt of a fire report; this is known as the "first attendance". On arriving at the incident, the officer-in-charge of the first attendance assesses the fire and the ability of the force and equipment under his immediate control to deal with it. If, in his judgment, more appliances are needed, or if at a later stage he finds that the fire is gaining, he requests assistance from the Watch Room. He may ask for any of the varied and specialised equipment—foam equipment, pump-escape, major pump, water tenders, turntable ladders, emergency tenders, salvage tenders, pump salvage tenders, fireboats, hose-laying tenders etc.—to meet the particular conditions.

During a recent oil fire at the Avonmouth docks, supplies of foam for fire fighting were urgently ordered from places as far away as London. Should a fire alarm occur at the Fawley (Hants) oil refinery, standing orders envisage a "first attendance" of no fewer than 50 appliances of various types. These two facts alone may help to give some idea of the volume and urgency of the traffic that arises after the initial report of the fire has been received. Figure 3 gives an extract from the record of the calls and moves made in connection with a fire that occurred at an Aldershot military establishment in November, 1950.

This brief account will show, I hope, that the Fire Service, in common with the other emergency services, relies considerably on the Post Office and the public telephone network for its emergency communications. It may well be that in the future the manpower shortage will cause more fire stations to be operated on a part-time or retained basis; if this is so, it seems likely that control will become more centralised on the County Fire Service administrative headquarters, with a consequent increase in the dependence of the Fire Service upon the Post Office. Telephone supervisors and operators will readily recognise the supremely important part they have to play in handling emergency communications, the importance of which will steadily increase if the further centralisation foreshadowed occurs.

I should like to express my thanks to Mr. F. V. Florance, of the Telephone Manager's Office, Southampton, for his willing assistance in obtaining information for the preparation of this article, to Mr. Paramor, of the Hampshire Fire Authority, and Mr. Barber, of the Home Office, for their courtesy and helpfulness and for their permission to take the photographs reproduced in this article.

The Commonwealth Telecommunications Board

by Colonel W. W. Shaw-Zambra, C.B.E., T.D., Secretary-General

NOT LONG AGO, MR. L. S. AMERY, ONE-time Secretary of State for Dominion Affairs, in advocating closer Commonwealth consultation and co-ordination in respect of the current problem of sterling, said :—

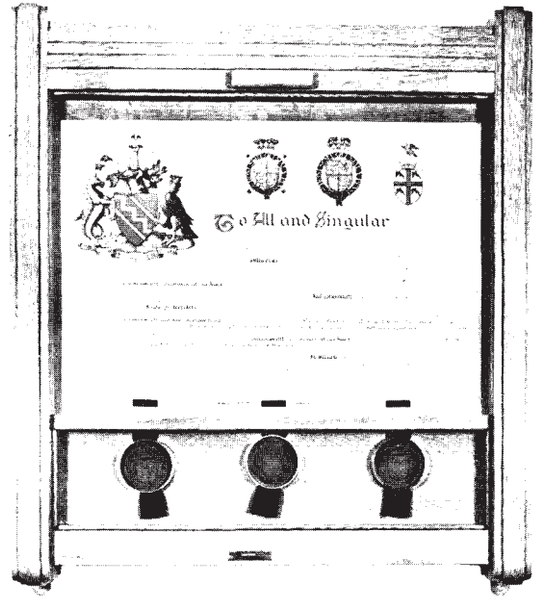
> "A somewhat similar problem has been successfully dealt with in the hardly less important field of cable and wireless communications, where the executive independence of the various Governments of the Commonwealth remains unimpaired, but where policy in its broader outline is co-ordinated by a body on which the views of all the Governments are represented".

He was referring to the Commonwealth Telecommunications Board, whose first General Report has recently been issued. As the Report contains a fairly full account of the Board's activities, this article will be more concerned with underlying principles, the *raison d'être* of the Board, its main functions and place in the general scheme of things, than with details of its work.

Although it was not until 1947 that the "Dominions Office" became the "Commonwealth Relations Office", the official use of "Commonwealth" in telecommunications began in 1942 with the "Commonwealth Telegraphs Conference" in Australia that year; and it was on a proposal made to that conference by Sir Campbell Stuart, then Chairman of the Imperial Communications Advisory Committee, that that Committee became, in 1944, the "Commonwealth Communications Council". Then, in 1945, there was the "Commonwealth Telecommunications Conference". Now the word is common form for conferences of all descriptions, and most committees and other bodies which used to be "Imperial" have become "Commonwealth".

This point has been dwelt on because it was the comparatively early appreciation, by those responsible for framing policy, of the importance of applying the new concept to problems (which had become acute) of the control of telecommunications as between the United Kingdom and the Dominions that has enabled the Dominions to achieve independent executive control with much closer association on policy matters than formerly. "Dominion" too is now almost outmoded, but it is used here for convenience, as no more appropriate single word has yet been found to take its place.

"For the purposes of promoting the efficiency and development of the external telecommunications service of the British Commonwealth and Empire", states the Commonwealth Telegraphs Agreement of 1948, "the Partner Governments agree to the establishment of a body which shall be known as the Commonwealth Telecommunications Board". The "Partner Governments" are those of the United Kingdom (which includes the Colonies), Canada, Australia, New Zealand,



The Grant of Arms to the Board

South Africa, India and Southern Rhodesia. Pakistan and Ceylon were not in the Agreement; India had not then been partitioned and Ceylon had not attained Dominion status. Southern Rhodesia, though at a political stage between self-governing Colony and full Dominion (as she still is), was treated as if she had Dominion status. The Agreement provides for the admission of new members. Ceylon was admitted on 1 June, 1951. The door stands open for Pakistan.

The Board was incorporated by an Act of the United Kingdom Parliament in 1949. "The Commonwealth Telecommunications Board shall be a body corporate by that name, with perpetual succession and a common seal, and with power to purchase, take hold and dispose of lands and other property". A familiar enough formula this, but rare certainly, unique perhaps, in its application to an instrument of Commonwealth government. True, there had been the Pacific Cable Board, constituted by Imperial Act of Parliament in 1901; but its sphere was limited (though later it acquired some cables and a wireless system in the West Indies) and its member Governments were four only, the United Kingdom, Canada, Australia and New Zealand. It was not until 1929 that a first general step towards co-ordination of policy in telecommunications was taken with the establishment of the Imperial Communications Advisory Committee, concurrently with the merger of cable interests with competing wireless interests in the company which became Cable and Wireless, Ltd. That committee, however, derived its powers, which were limited to certain concerns of Cable and Wireless, Ltd., from clauses in a very different kind of document, an agreement between the Company and the United Kingdom Treasury, the Treasury acting on behalf of the United Kingdom Government with the concurrence of the governments of Canada, Australia, New Zealand, South Africa, the Irish Free State and India; and the Agreement itself was operative only for so long as any licence or authority granted by the United Kingdom to the Company for the maintenance of cables and the maintenance and working of wireless telegraph stations should be in force. From 1944 to 1946, the Commonwealth Communications Council was virtually in the same position, but in 1947, by agreement between the Governments, it was empowered to assume as many as possible of the functions assigned to the Board, pending the latter's incorporation.

What, then, does this new departure imply? A committee is gathered together as occasion demands and, except when actually meeting, its members normally have little cohesion. A body corporate, however, is essentially something with a life of its own, is expected to develop a corporate sense and is, in fact, intended to be of greater significance than the mere sum of its parts.

What led the Governments to make this move? After all, Commonwealth consultation is continuous: it goes on day by day through the High Commissioners in all the Commonwealth capitals. The reason, apparent to the Governments, was that their individual requirements necessitated not merely bi-lateral functional association and co-operation between their respective telegraph and telephone administrations—which, perforce, is normal up to a point, in all international telecommunications—but in addition such a considerable degree of functional co-ordination that a central co-ordinating body of a more permanent, authoritative and independent-minded nature than a committee was essential. This was the more so because, with the acquisition by the Governments of the local assets of Cable and Wireless, Ltd., and other companies operating external telecommunications on their territories, there disappeared the considerable measure of co-ordination performed by the Company at certain levels in the normal course of its relations with the associated companies; for, as has already been mentioned, the Advisory Committee had only limited functions as regards Cable and Wireless, Ltd., and none at all directly as regards the other local companies.

The historical background to the Commonwealth Telegraphs Act was given in some detail in the August, 1949, *Post Office Telecommunications Journal;* it is necessary here to recall only the salient facts, to help towards understanding why certain of the Board's functions have been given to it.

Beam wireless telegraph services had been opened by the United Kingdom, through the Post Office, with Canada in 1926, and with Australia, South Africa and India in 1927, the conduct of these services in the Dominion countries being in the hands of private wireless companies licensed by their respective governments. By 1928, the success of these services was not only rapidly producing a critical state in the affairs of the privately-owned, almost world-wide, cable system of the Eastern and Associated Telegraph Companies, but was also very severely affecting the revenues of the joint Government-owned cables

The Commonwealth Telecommunications Board in session.

Left to right: **C. F. Brimblecombe, S. Rhodesia P.O.; E. Bridgnell, M.B.E., Observer** *(Pakistan)*; **Lt.-Col. H. Myers, O.B.E., Div. Controller, S. African P.O.** *(S. Africa)*; **R. V. McKay, Asst. D.G. (E-in-C.), Australian P.O.** *(Australia)*; **Col. A. H. Read, C.B., O.B.E., T.D., Dir. Overseas Telecommunications, P.O. London** *(U.K.)*; **Col. W. W. Shaw-Zambra, C.B.E., T.D. Secretary-General; A. F. E. Evans, O.B.E., Engineer Officer; Col. Sir Stanley Angwin, K.B.E., D.S.O., M.C., T.D., former E-in-C., G.P.O., London, and Chairman, Cable and Wireless Ltd.** (Chairman); **W. W. Dimon, Finance Officer; H. Everett, Asst. Secretary; J. H. Tudhope, M.C., Telecommunications Attaché, Canadian High Commissioner's Office** *(Canada)*; **J. G. Young, C.B.E., former D.G., New Zealand P.O.** *(New Zealand)*; **M. A. J. Vasnaik, former P.M.G., Madras** *(India)*; **A. I. Perera, C.B.E., former P.M.G. and Dir. Telecommunications, Ceylon** *(Ceylon)*; **G. H. Webster, C.M.G., O.B.E., former P.M.G., Palestine** vice-Chairman 1951-52.

of the Pacific Cable Board and those of the Imperial cables across the Atlantic owned by the United Kingdom Government.

For economic and strategic reasons—the latter a lesson of the 1914-18 War—the Governments decided that the cables must not be driven out of existence by wireless competition. The 1929 arrangements were an attempt to solve the problem on semi-public-utility lines. They consolidated the position in the United Kingdom to a large extent, at all events on the telegraph side, but although efforts were made to achieve the same solution in the Dominions, they were not wholly successful. Nevertheless, the United Kingdom Company, for its part, was able to pursue with some success a policy of integrating its wireless services with its cable services. The War of 1939-45 brought new problems. Among them was the opening of direct wireless circuits between some of the Dominions and the U.S.A., thus diverting traffic from passing through the United Kingdom and causing loss of revenue to the United Kingdom Company.

So, in 1945 as in 1928, the economics of cable services in the face of competing wireless services had again become a problem, though this time in a different form. By this time, too, most of the Dominions had become dissatisfied with the 1929 arrangements, which had in fact, if not in expectation, resulted in rather more dependence on the United Kingdom Company than some of the Dominions were any longer prepared to accept. The result this time has been full public ownership and operation. All the Partner Governments signatory to the Commonwealth Telegraphs Agreement, 1948, have acquired the assets of Cable and Wireless, Ltd., and its associated companies in their respective territories. The operation of the services is now entirely in the hands of the Governments. In consequence, there has now been local consolidation everywhere (except Pakistan) on both the telegraph and telephone sides. With two exceptions, the operating bodies are government departments. Whatever their form, they are known as the "National Bodies". The Partner Governments have full sovereignty over their respective National Bodies

and the latter have sole executive responsibility for operating the overseas telecommunications systems in their own territories. In the United Kingdom, the Post Office is the National Body, since it now operates the services in the United Kingdom formerly operated by Cable and Wireless, Ltd., but the long-standing arrangement under which four foreign companies operate overseas telegraph services in the United Kingdom, under licence from the Postmaster General, has not been disturbed. Cable and Wireless, Ltd., retains its identity as a limited liability company, operating its cable station in the United Kingdom and its wireless and cable stations in the United Kingdom colonies and certain foreign countries.

The Board's principal functions, as laid down in its constitution, are :—

"To make recommendations to the Partner Governments and to National Bodies on the following matters relating to their external telecommunication systems:—

The formulation and execution of the joint telecommunication policy of the Partner Governments, including the fixing of rates;

Co-ordination of the development of the cable and wireless systems of the British Commonwealth and Empire;

Extensions to and alterations of the telecommunication systems of the British Commonwealth and Empire;

The provision and, where appropriate, the apportionment among National Bodies, of capital expenditure on projects;

Co-ordination with the appropriate authorities on telecommunication matters affecting the defence of the British Commonwealth and Empire or any part thereof;

Co-ordination of research in telecommunication matters conducted by National Bodies;

Any other telecommunication matter which may be referred to the Board by any of the Partner Governments or by any National Body;"

"At the request of the Partner Governments or National Bodies to conduct negotiations with foreign telecommunication interests on their behalf;

"To promote and conduct research in telecommunication matters".

Three important points are at once apparent. One, the Board is mainly advisory, not executive: two, though mainly advisory, its functions are very wide: three, it has statutory relations with both Partner Governments and National Bodies. These relations will be explicitly defined in separate tripartite (or bipartite) agreements between Partner Governments, Board and National Bodies. The agreements will, moreover, determine the financial arrangements between National Bodies, in respect of which the Board has an important supervisory function.

The current financial arrangements, which came into effect on April 1, 1950, subject to a review at the end of the first year's working, were in fact adopted by the Partner Governments on recommendations made by the Board in February, 1950. The basic concept is that the respective National Bodies are "common users" of the Commonwealth and Empire cable and wireless systems. Instead of National Bodies making the payments that would normally be due on balance as between one operating body and another for transmitting each other's traffic, the expenses incurred by each National Body in operating and maintaining its part of the common-user system and the net revenue derived by each National Body from its own public and from foreign sources are calculated in an agreed manner. The total expenses are then allocated among National Bodies in the proportions which the net revenue of each bears to the total net revenue of all; and this constitutes the settlement of their indebtedness one to another for use of the common-user system.

The Board will be responsible for prescribing from time to time, with the concurrence of the Partner Governments:—

(1) what constitutes the Commonwealth common-user system;
(2) the expenses which are to be accepted as expenses of this common-user system, and the manner in which they are to be computed;
(3) the manner in which the net revenue of each National Body is to be computed;
(4) what settlement shall be made between the National Bodies in respect of unbalance of traffic;
(5) the manner in which sums payable in settlement of unbalance of traffic shall be calculated;
(6) the necessary accounting arrangements;
(7) times and manner in which sums due from the National Body to the Board or to another National Body, or from the Board or another National Body to the National Body, shall be paid; and
(8) the currencies in which accounts are to be prepared.

The table on page 157 shows how this "common-user" system, for which the Board is the central co-ordinating authority, is distributed among the National Bodies.

It will be seen that the transfer from private to public control throughout the Commonwealth has left the United Kingdom—through either the Post Office or Cable and Wireless, Ltd.—with the ownership of, and responsibility for the maintenance of, practically the entire cable network. A few local cables only are owned by other National Bodies and these do not form part of the common-user system. Complementary to the cable network, and in large part closely integrated with it, the

United Kingdom National Body owns an extensive radio network, operated in conjunction with the Commonwealth stations owned by other Partner Governments, or with overseas stations controlled by Cable and Wireless, Ltd.

Through its combined cable and radio network, over from Cable and Wireless, Ltd., or via their respective circuits with United Kingdom radio stations. Where circumstances have required and satisfactory radio propagation conditions exist, direct radio circuits have been set up between some of the other Commonwealth countries, thus

National Body	Cable Stations	Radio Stations
	United Kingdom	
Post Office	*Post Office*—Cables under English Channel and North Sea with Continental countries. Cable-laying ship H.M.T.S. "Monarch." Three repair and maintenance ships.	
	Thirteen stations along south and east coasts of England for the Anglo-Continental services.	In the United Kingdom, at Criggion, Cupar, Rugby, Snitterfield, Leafield, Baldock, Ongar, Brentwood, St. Albans, Cooling, Somerton, Dorchester and Bodmin.
	Cable and Wireless, Ltd.—Cables in N. and S. Atlantic, Pacific, Indian Ocean, Mediterranean and Red Sea, 155,000 nautical miles in all. Eight repair and maintenance ships.	
	Porthcurno, in Cornwall, and some 70 overseas, not operated by national bodies.	Twenty-six overseas, not operated by national bodies.
	Canada	
Canadian Overseas Telecommunications Corporation.	Harbour Grace, Halifax and Bamfield, with inter-connecting landlines between these stations and Montreal, linking North Atlantic and Pacific cables.	Yamachiche and Drummondville.
	Australia	
Overseas Telecommunications Commission (Australia).	Perth, Sydney and Southport, with inter-connecting landlines, linking Pacific and Indian Ocean cables.	Pennant Hills, La Perouse, Fiskville, Rockbank and Braybrook.
	New Zealand	
Post and Telegraph Department.	Auckland and Muriwai, with inter-connecting landlines. The cable between Sydney, Australia, and New Zealand terminates at Muriwai; the Norfolk Is. and Suva cables to New Zealand terminate at Auckland. This network provides alternative routing between Australia, New Zealand, Fiji and the Pacific cables.	Wellington, Makara and Musick.
	South Africa	
Department of Posts and Telegraphs.	Capetown and Durban, with inter-connecting landlines, linking S. Atlantic and Indian Ocean cables.	Derdepoort, Robert's Heights, Klipheuwal and Milnerton.
	India	
Ministry of Communications (Overseas Communications Services).	Bombay and Madras, with inter-connecting landlines, providing alternative routing from Red Sea cables to the Far East.	Delhi, Kirkee and Dhond.
	Ceylon	
Post and Telecommunications Department.	Colombo, with facilities for relaying traffic to the Far East.	Colombo.
	Southern Rhodesia	
Posts and Telegraphs Department.		Hillside and Hatcliffe.

Distribution under the "common-user" system

the United Kingdom provides the other Commonwealth countries with routes to all parts of the world. The other countries can trunk-in to the network; either directly into the cables at the cable stations in their own territories which they took relieving the London Central Telegraph station of some of the intra-Commonwealth traffic. The radio circuits maintained by the other Commonwealth countries with foreign countries have been established, from time to time, for some specific

The vice-Chairman, 1951-52 (G. H. G. Webster, Colonies Member). Each member's office at 28, Pall Mall, has the coat of arms of his country on the door

reason that has made direct communication necessary. These circuits are limited to traffic terminating in the two countries concerned.

The Chairman of the Board is independent, appointed jointly by the Partner Governments. The first Chairman was Lord Reith, who at the request of the United Kingdom Government had visited all the countries of the Partner Governments in 1945, had been Chairman of the Commonwealth Telecommunications Conference later that year and had become Chairman of the Commonwealth Communications Council in 1946. In 1951, Lord Reith was succeeded by Sir Stanley Angwin, who had just relinquished the chairmanship of Cable and Wireless, Ltd., to which he had been appointed on his retirement as Engineer-in-Chief of the Post Office.

The Board is composed of a group of men all with wide and varied experience in telecommunications, some having held the highest executive posts in their home administrations. Between them they pool a fund of extensive knowledge on nearly every aspect of the subject. This enables the Board itself normally to conduct the detailed examination of matters referred to it by Partner Governments. All communications from the Board to Partner Governments or National Bodies pass through the members.

Apart, however, from current matters referred by Partner Governments, the Board has itself initiated studies on certain other matters and is progressively extending these, in order, as far as possible, to anticipate problems, particularly those of technics and traffic, which are likely to confront the operating National Bodies in both the near and distant future. For these purposes it works mainly through study groups. These groups do not always consist solely of members of the Board, who are all, however, entitled to attend any group. Formal committees are set up, of course, when circumstances require. Despite the wide scope of the Board's functions, it is not intended to build up a big organisation.

As the main purpose is advisory and co-ordinating, the Board believe that they can do this best by calling mainly on the experts of the Partner Governments and National Bodies, rather than by appointing many experts to their Secretariat. The staff number some thirty. The Assistant Secretary, Mr. H. Everett, was Secretary of the United Kingdom Radio Board and a joint Secretary of the Imperial Communications Committee of the War Cabinet. The Engineer Officer, Mr. A. F. E. Evans, was at one time in the United Kingdom Post Office Engineering Department and more recently was Regional Director in the Egyptian Administration and a Divisional Engineer in the Colonial Service.

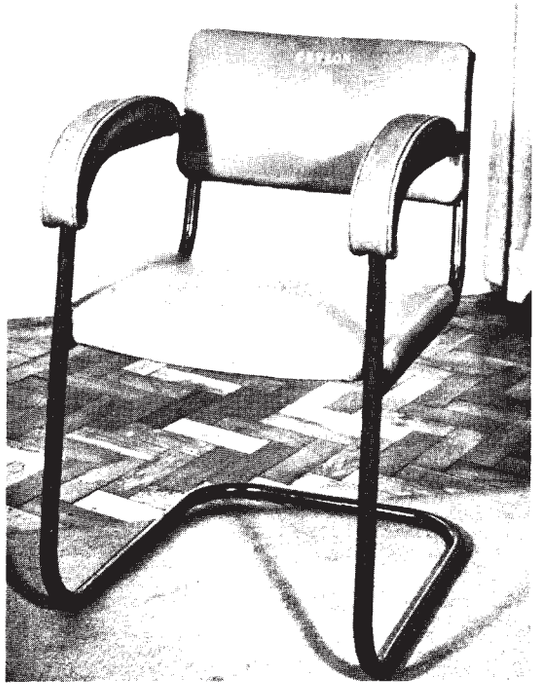
The members all live in London and each is provided with his own office at the Board's headquarters at 28, Pall Mall, within easy access of most of the High Commissioners' Offices. The Board's work has so far required on the average at least one meeting a week, often two—either full Board, committee or study group. The work of members and secretariat between meetings is continuous. It is this continuity, the members all being in one building, and in almost daily touch with the Chairman and secretariat, that does much to foster the corporate sense. The Board's approach to problems has been objective and empirical; the legalistic approach, that pitfall of a written constitution, has been avoided. What counts is the recognition by the members that the points on which all can agree are more important than those on which they differ.

Here is just one example of how the Board plays its part. The bad radio propagation conditions experienced during the winter of 1950-51 necessitated, at times, the transfer of large blocks of radio traffic to the cable system. This gave rise to

complaints about delays, particularly by the Australian Press. In January, 1951, the Australian Government referred the matter to the Board, requesting that the position be examined to ascertain definitely whether the existing services between the United Kingdom and Australia were adequate and whether provision was being made for developing satisfactory services to meet further requirements. The Board at once invited the United Kingdom to prepare a complete statement of the position, and, as this was a formal matter raised by a Partner Government, appointed a committee composed of the South African Member (Chairman), the Australian Member and the Colonies Member, with a representative of the United Kingdom National Body, to investigate and report. The Committee went exhaustively into the causes of the delays and their extent; it examined all the alternative routes available between the United Kingdom and Australia and New Zealand, their circuit capacity and technical characteristics; and considered the use made of them by the National Bodies in disposing of the traffic.

In April, 1951, the Board was able to report to the Governments on the steps thought necessary to be taken by National Bodies to prevent a repetition of the trouble, or at any rate to mitigate its effects as far as possible. The Board's findings are given in the General Report and need not be repeated here. What is important is the result. Some immediate steps have been taken by the United Kingdom National Body in co-operation with other National Bodies to strengthen the position on both the cable and the radio side. Others are under discussion between the National Bodies. The Board itself is undertaking a comprehensive study of the entire Commonwealth cable network, with a view to preparing a long-term programme for the progressive improvement of the network, in the light of the latest results of scientific research in cable manufacture and the technique of cable operation, and with particular attention to the integration of cable circuits with radio circuits. The Board paid special tribute to the co-operation of all the United Kingdom authorities concerned in this enquiry, which, as the Report says, was undertaken in the spirit of close collaboration between Board and National Bodies that the Board's constitution implies.

We all realise to-day that the Commonwealth is facing a world situation in which it will be fatal to have illusions. If the almost unlimited potentialities of the Commonwealth are to be fully developed, an efficient and up-to-date telecommunications system is a *sine qua non*. The United



In the Board Room, each member has a chair with his country's name on it above the Board's coat of arms

Kingdom is still the banking and trading centre for nearly one fourth of the peoples of the earth, and it has been shown above that in the Commonwealth telecommunications system she is still the major partner. She earns the biggest revenues, but she also bears the heaviest risks. The Board's responsibility is to see that the Commonwealth is provided with a fast and dependable overseas telegraph and telephone service, adequate for all normal civil needs and competent to meet emergency and defence demands. The methods by which the National Bodies will contribute to the ends in view are within their own discretion and will vary according to their individual circumstances. The Board fully realises that there is much work still to be done before these objectives can be completely attained and that it will demand clear sighted thinking—not only by the United Kingdom, on whom rests the greater share of the burden, but no less by the other Commonwealth countries in the partnership, who now have their full share in formulating policy.

Readers are referred to the informative article by the Traffic Department of Cable and Wireless, Ltd., published recently in this Journal, on problems of the circulation of overseas telegraph traffic.—*Editor.*

Micro-waves in Telecommunications

by W. J. Bray, M.Sc. (Eng.) A.M.I.E.E.,
Engineer-in-Chief's Office

MICRO-WAVES ARE WIRELESS WAVES OF the same general nature as those used in broadcasting, but they are of much higher frequency and are therefore of much shorter wavelength. The waves used for medium-wave broadcasting are generated at frequencies of ½ to 1½ million cycles per second and their wavelengths are between 600 and 200 metres; micro-waves used for point-to-point radio relaying are generated at frequencies from 1,000 million to 10,000 million per second and the wavelengths are between 30 and 3 centimetres.

It seems probable that, because they can be directed along narrow beams and can carry television programmes or a large number of telephone and telegraph channels, micro-waves will be used to an increasing extent in the telecommunications network of the future, not only in Great Britain but also in many overseas countries; it may therefore be of interest to review briefly the history and characteristics of micro-waves and their application to telecommunications.

Early History of Micro-waves

Micro-waves are as old as radio itself; indeed, the first demonstrations of the wave nature of electromagnetic radiation were carried out by Heinrich Rudolf Hertz in the period 1886-9, using wavelengths in the range 30 to 100 centimetres.[1]* Hertz even employed parabolic mirrors to concentrate the waves into sharp beams (Fig. 1), much as in a modern radio relay system. In this early micro-wave link, the transmitter consisted of a spark coil energising a resonator placed at the focus of a parabolic mirror; the receiver comprised a resonator and mirror similar to that used at the transmitter, the received signals being detected by the weak sparks that appeared across the gap of the receiving resonator. However, Hertz did not apparently appreciate the possibility of communicating over large distances by micro-waves, since he is reported to have said that it "would need a mirror as large as a continent"!

The first theoretical analyses of the propagation of micro-waves in metallic pipes were made in Great Britain by J. J. Thomson in 1893[2] and Lord Rayleigh in 1897.[3] It says much for the insight of these pioneers that they were able to predict the possibility of guided waves long before this was demonstrated experimentally. In fact, the experimental investigation of micro-waves was largely at a standstill until about 1933, when Dr. G. C. Southworth, of the Bell Telephone Laboratories in the U.S.A., began a series of investigations that were ultimately to have far-reaching effects on the development of radar, as well as on the use of micro-waves for telecommunications.

By 1939, many workers in various countries had entered the micro-wave field and by that time the main characteristics of these waves had been established and a foundation laid for the new science of radar. The contributions made by British scientists such as Sir Edward Appleton and Sir Robert Watson-Watt are too well known to need comment here. The war gave a considerable impetus to the development of micro-waves for radar, in which this country was in advance of all others, but most of the applications of micro-waves to telecommunications had to wait until after the war.

Generation, Amplification and Detection of Micro-waves

Before micro-waves can be used, satisfactory means must be available for their generation, amplification and detection.

A commonly used generator of micro-waves for communications purposes is the reflex klystron oscillator,[4] a typical valve being shown in Fig. 2. This valve employs a hollow, ring-shaped, resonant

* *All references are to bibliography at end of article.*

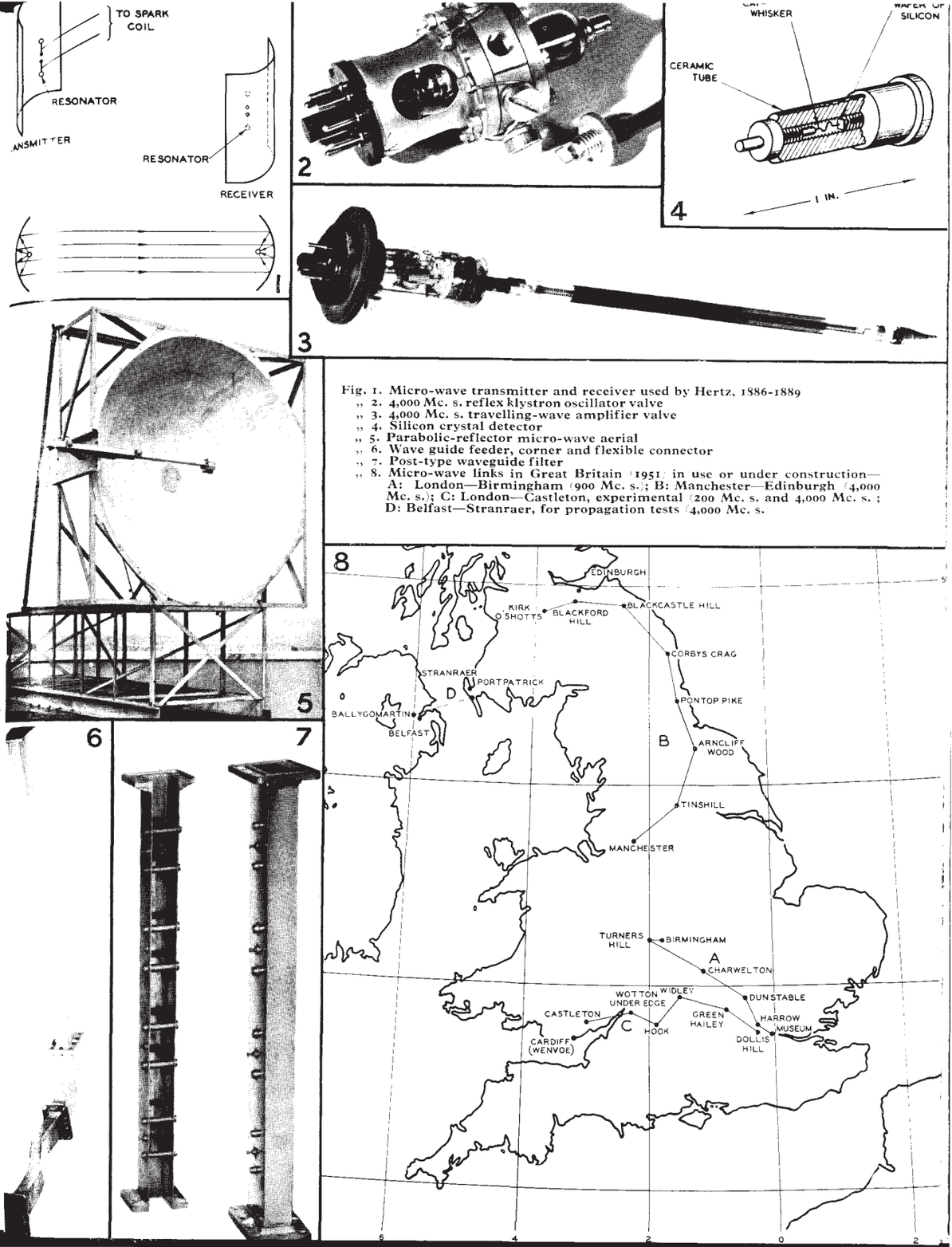


Fig. 1. Micro-wave transmitter and receiver used by Hertz, 1886-1889
„ 2. 4,000 Mc. s. reflex klystron oscillator valve
„ 3. 4,000 Mc. s. travelling-wave amplifier valve
„ 4. Silicon crystal detector
„ 5. Parabolic-reflector micro-wave aerial
„ 6. Wave guide feeder, corner and flexible connector
„ 7. Post-type waveguide filter
„ 8. Micro-wave links in Great Britain (1951) in use or under construction—A: London—Birmingham (900 Mc. s.); B: Manchester—Edinburgh (4,000 Mc. s.); C: London—Castleton, experimental (200 Mc. s. and 4,000 Mc. s.; D: Belfast—Stranraer, for propagation tests (4,000 Mc. s.

cavity, the cavity being maintained in oscillation by a beam of electrons passed through two axial holes in the top and bottom surfaces of the cavity. The wavelength of the oscillations thus generated is approximately proportional to the dimensions of the resonant cavity; the wavelength can be varied over a small range by adjusting the tuning screws, which in effect slightly change the dimensions of the cavity. The valve shown in Fig. 2 can be tuned over a range of about 500 Mc. s. centred on 4,000 Mc. s. The power output is about 0.1 watt. The reflex klystron oscillator is particularly suitable for use as a frequency-modulated source, that is a source the frequency of which is varied by the signal it is desired to transmit, since the frequency can be varied over a range of some 10 Mc. s. by varying the potential of one of the electrodes.

Travelling-wave Valve

The most effective amplifier for micro-waves that has been devised up to the present time is undoubtedly the travelling-wave valve;[5] this valve was invented by R. Kompfner working at the Clarendon Laboratory, Oxford, and at Birmingham University during the period 1942-4. A typical 4,000 Mc. s. travelling-wave valve having a power amplification of about 100 times (20 db.) and a maximum power output of 2 watts, is shown in Fig. 3. The valve contains a closely wound wire helix, along which the wave to be amplified is propagated. A narrow beam of electrons is passed down the centre of the helix and amplification occurs as a result of interaction between the wave on the helix and the electron beam. A valuable feature of the travelling-wave valve is the remarkably wide band width over which amplification is obtained. The valve shown in Fig. 3 is an effective amplifier over a band of at least 500 Mc. s. By way of comparison, it may be noted that the whole of the medium-wave broadcast band is only 1 Mc. s. wide.

Micro-waves can be detected—that is rectified—by silicon crystals[6] that are similar in principle to the cat-whisker crystal detectors used in the very early days of broadcasting; the modern silicon crystal detectors are, however, pre-set and are much more robust than their predecessors. A typical modern silicon crystal-valve is shown in Fig. 4. These crystal-valves are also used as highly efficient frequency-changers—for example, for converting an incoming signal at 4,000 Mc. s. to an intermediate frequency of 60 Mc. s. for subsequent amplification; for this purpose, the silicon crystal-valve is supplied with a carrier at 3,940 Mc. s. from a reflex klystron oscillator.

Because of the very short wavelengths employed, it is possible to concentrate the radiation from a micro-wave transmitting aerial into a narrow beam; this is a considerable advantage for point-to-point relaying, since very little energy is wasted by being radiated away from the distant receiver. Similarly, the receiving aerial can be designed to respond only to signals incoming within a narrow range of angles and to reject other signals or interference arriving from other directions.

A typical micro-wave aerial for use at 4,000 Mc. s. is shown in Fig. 5; it consists of a parabolic mirror 7 feet in diameter, with the open end of a waveguide feeder at the focus. This aerial has a beam width of about 2.5 , the power gain relative to a non-directional aerial being about 4,000 times (36 db.)

The losses in coaxial feeders are generally too large for use with micro-waves, waveguide feeders being generally employed, for example, to connect an aerial at the top of a tower to a micro-wave transmitter or receiver at ground level. Feeders for use at 4,000 Mc. s. usually consist of rectangular-section copper tubes, outside dimensions $2\frac{1}{2}$ by $1\frac{1}{4}$ inches, in lengths of up to 10 feet, bolted together by suitable flanged connectors; the losses are about 1.5 db. per 100 feet. A typical waveguide feeder, a waveguide corner and a flexible section are shown in Fig. 6.

Filters may be required in micro-wave systems to separate the wanted signals from others in the adjacent frequency bands. Simple, robust filters can be made in waveguide form for this purpose; one form, shown in Fig 7, comprises a series of vertical metal posts arranged in pairs along the centre of the waveguide, each pair constituting a resonant circuit tuned over a limited range of frequency by a screw between the posts. Such a filter can have a pass-band 20 Mc. s. wide and attenuate the power of signals more than 40 Mc. s. from the centre of the pass-band at least 10,000 times (40 db.)

Propagation of Micro-waves

Micro-waves must have a substantially unobstructed path between the transmitting and receiving aerials at opposite ends of a link; if the path is obstructed by hills or trees, for example, the received signal level falls to a low value. Because

of the very short wavelength used, the obstruction produces a radio "shadow", much as an opaque object produces a shadow when a beam of light falls on it. In general, the direct ray path between the transmitting and receiving aerials should clear the intervening terrain by at least 100 feet, and it is thus often necessary to site micro-wave repeater stations on hill tops and, in some cases, to use towers to support the aerials.

Micro-waves are subject to fading at times, due to variations in the refractive index of the atmosphere. Changes in the rate at which the temperature of the atmosphere decreases with height, or variations in the distribution of the moisture content, may modify the normal decrease of refractive index with height and cause the ray paths to bend downward, thus reducing the clearance above the earth or even causing the earth to appear as an obstruction in the path. Reflections from the surface of the sea may also cause fading in over-sea links by tending to cancel the signals received over the direct path between the transmitting and receiving aerials. Studies of the propagation over various land and sea paths have shown that, in general, paths up to about 40 miles long can be employed successfully and that transmitted powers of about one watt are adequate at 4,000 Mc. s. for relaying television signals or several hundreds of telephony channels.

Micro-wave Links

The micro-wave links existing in Great Britain at the present time, or which are under construction, are shown in Fig. 8; they are London—Birmingham (900 Mc. s.),[7] Manchester—Edinburgh (4,000 Mc. s.)[8] and London—Castleton, South Wales (200 Mc. s. and 4,000 Mc. s.).

The first two links have been designed primarily for relaying television signals; the third is an experimental link between the Post Office Radio Laboratories at Dollis Hill, London, and Castleton, South Wales. An experimental link for studying propagation at 4,000 Mc. s. on an over-sea path has also been set up between stations near Belfast and Stranraer.

In France, a one-way link operating on about 900 Mc. s. exists between Paris and Lille and is in use by the Radio-Diffusion Française for relaying television signals; a more complex system operating on about 3,750 Mc. s. and capable of providing three two-way television channels, each 10 Mc. s. wide, is under construction between Paris and Lille for the French Post Office Administration.[9]

In the United States, the Bell System has designed and constructed a 4,000 Mc. s. radio relay system linking New York, Chicago and San Francisco,[10] spanning a distance of some 2,900 miles, with 106 repeater stations in tandem. This system provides at present two two-way television channels, each 8 Mc. s. wide, with an ultimate capacity of six television channels; it is claimed that each television channel can be used for several hundred telephony channels. The Western Union Telegraph Company have in operation a 4,000 Mc. s. radio relay system linking New York, Pittsburgh, Philadelphia and Washington, which provides an ultimate capacity of some 1,000 V.F. telegraphy channels.[11]

In this short survey it has been possible only to touch briefly on the main characteristics of micro-waves and their applications. Nevertheless, perhaps enough has been said to indicate that micro-waves constitute a transmission technique with considerable potentialities. Much work remains to be done, particularly on the development of simpler and cheaper repeaters and long-life micro-wave valves.

Nothing has been said on the relative merits of micro-wave links and coaxial cable links; there is undoubtedly a place for each in the main transmission network of the country, and the extent of use of micro-waves is a matter that can be safely left to the future to resolve.

The author's thanks are due to Electric and Musical Industries and Standard Telephones and Cables for permission to publish Figs. 2 and 3 respectively.

Bibliography

(1) "Pioneers of Electrical Communication", Rollo Appleyard, Macmillan, 1930, p. 109.
(2) "Recent Researches in Electricity and Magnetism", J. J. Thomson, 1893.
(3) "On the Passage of Electric Waves Through Tubes, or the Vibrations of Dielectric Cylinders", Lord Rayleigh, Phil. Mag., 43, 1897.
(4) "Velocity Modulation Valves", L. F. Broadway and others, J.I.E.E., 93, Part IIIA, 1946, p. 855.
(5) "The Travelling-Wave Valve as Amplifier at Micro-waves", R. Kompfner, Proc. I.R.E., 35, Feb., 1947, p. 124.
(6) "Crystal Valves", B. Bleaney and others, J.I.E.E., 93, Part IIIA, 1946, p. 847.
(7) "The London—Birmingham Television Radio-Relay Link", R. J. Clayton and others, J.I.E.E., 98, Part IIIA, July 1951, p. 204.
(8) "The Manchester—Edinburgh Television Radio Relay System", A. H. Mumford, P.O.E.E.J., 44, April, 1951, p. 33.
(9) "Le Relais Paris-Lille", La Radio Française, May, 1951.
(10) "The TD—2 Micro-wave Radio Relay System", A. A. Roetken, K. D. Smith and R. W. Friis, B.S.T.J., 30, Oct., 1951, p. 1041.
(11) "Radio Relays for Telegraphy", F. B. Bramhall, Electrical Engineering, Nov., 1946, p. 516.

NOTES AND NEWS

Transit Phototelegraphs — Phototelegraphy and Red Cross — Electronic Directors — Telephone Staffing — Patron of Telecommunications — Civic Visit to Whitehall — Coloured Labels — Auxiliary Automatic Intercomm. Systems — "Restricted" Service — Old-time Call Office Keys — Broadcast Relay Licences — British Industries Fair — I.P.O.E.E. Competitions.

Transit Phototelegraph Services.—For some time it has been realised that London is well situated as a potential transit centre for phototelegraph traffic between Europe and the rest of the world.

A step towards this end was taken on the 18th May by the transfer of the European line phototelegraph services from the Central Telegraph Office to Electra House ("London Station" of the Post Office Cable and Wireless services), which operates a few radio services to Europe, but the great majority of its services are to the British Commonwealth and the American continent.

The combined wire and radio unit was first used as a transit centre on the 20th May, as a result of a request the previous day from a customer in Greece, who asked for a photograph to be transmitted from Paris to Greece. A suitable rate was agreed by all three countries and the picture went through without incident.

Standard rates for through pictures have been agreed for services between Belgium, Sweden, Norway and Finland on the one hand and the British Commonwealth and the American continent on the other. Special steps have been taken to ensure that the transit services with Finland will be ready for use in time for the Olympic Games. The remaining European administrations have all been approached and it is hoped that full transit facilities will soon be available between all European and extra-European countries to which the Post Office has direct access.

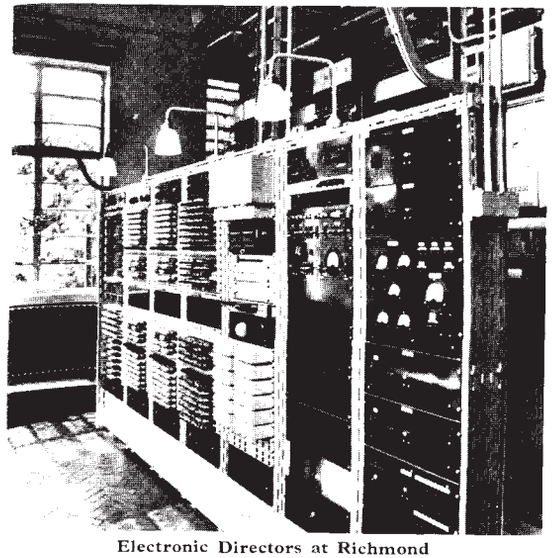
As regards actual transmission, all pictures are relayed through London automatically, wherever possible; but because of the "temperamental" qualities of radio transmission, it is not always possible to do this, and the pictures are then reproduced and retransmitted from London Station. The advantages of being able to do all this in one picture room will be readily appreciated.

★ ★ ★

Phototelegraphy and the International Red Cross.—An interesting enquiry was received early this year from the International Red Cross Committee, who were investigating the possibilities of phototelegraphy in transmitting vital documents between Switzerland and combatant countries in the event of serious international disorders. This would have obvious advantages, of course, in that the documents would not be held up by intermediate censorship or any other material difficulties in transit countries.

The British and American administrations were asked to co-operate in transmitting, as an experiment, photostats and microfilms of certain Red Cross documents. These were sent by line from the C.T.O. and by radio from Electra House.

The results of the tests confirmed the view of the Post Office, already expressed in writing to the Red Cross, that the print in the documents, particularly the microfilm, was far too small for satisfactory reception. The tests have shown, however, that transmission will be possible, providing good quality, clearly printed documents of a standard size and colour are used.



Electronic Directors at Richmond

Experimental Electronic Directors at Richmond.—During recent years there have been very rapid advances in the development of electronic techniques and in their application to a wide variety of purposes such as the construction of computors and the so-called "electronic brain". Post Office Engineers at the Dollis Hill Research Station have been studying the application of these techniques to automatic telephone exchanges. Their aim is to provide telephone exchanges operated entirely by electronic means instead of by the present type of electro-mechanical switch. The electronic apparatus has no moving parts, it is almost instantaneous in operation, and may eventually prove cheaper to instal and maintain than our present-day exchanges. Six electronic directors have been constructed in the Post Office Laboratories and have recently been brought into service at Richmond Telephone Exchange in London. The director is that part of the exchange equipment which, in large cities such as London, responds to the three letters dialled by the subscriber and steers his call to the wanted exchange. A single director does this for about half a million calls a year; with the present type of electro-mechanical director, the operation is somewhat noisy and there is a good deal of mechanical wear brought about by the hard usage. The electronic director has no moving parts and does its work silently.

The installation at Richmond is experimental and is believed to be the first instance of the use of a fully electronic item of switching equipment in a public telephone system in the world and places this country in the front line of development in this new field.

There are, however, many research problems and practical difficulties still to be overcome and it will be some years before the new idea can be developed as a complete system for installation in our exchanges.

★ ★ ★

Telephone Staffing and Service.—During the early months of this year, there was a considerable increase in the number of candidates applying for employment as telephonists, particularly in London, and this enabled staff to be recruited to fill vacancies that had existed at many exchanges. Whereas in 1951 the London telephonist staff was about 1,400 below strength, this deficiency has now been made good, with applications for employment being received at a rate of as many as 700 in a week. There has been a similar marked improvement in a number of provincial towns. In consequence of the more satisfactory staffing position, the service has improved. During the quarter ending 31st March, 1952, the national average time to answer on trunk and toll calls was 5.7 seconds, as compared with 9.4 seconds in the first quarter of 1951, and rather better than the pre-war figure.

★ ★ ★

In an apostolic brief, the Pope has named the Archangel Gabriel as the patron of telecommunications. We present an artist's conception of Gabriel in this aspect.

Gabriel, in Jewish and Christian literature, is one of the seven archangels who occupy the front rank in Heaven. By repute, he is the messenger of God, and is first named in the Book of Daniel: ". . . even the man Gabriel . . . being caused to fly swiftly . . . informed me and talked with me". St. Luke represents him as announcing to Zacharias the birth of John the Baptist—"I am Gabriel that stand in the presence of God, and am sent to speak with thee" —and to Mary the birth of Christ.

Mayoral Visit to Whitehall.—On the 15th May, the Whitehall Telephone Exchange (Centre Area, London Telecommunications Region) was honoured for the first time in its history by a civic visit by the Right Worshipful Mayor of the City of Westminster, Councillor A. Sciver, J.P., B.Sc., F.R.I.C.

The mayoral party was received by the Telephone Manager, Mr. H. M. Turner, A.M.I.E.E., together with the Heads of Divisions and the Chief Supervisor of the exchange. Mr. C. O. Horn, Deputy Regional Director, was present as a guest of honour.

The west wing of the building, which contains the famous Nell Gwynne staircase (a feature which distinguishes this exchange from all others as being the only one, part of which is scheduled as an ancient monument), was thrown open for the occasion.

★ ★ ★

Coloured Labels.—Telephone operators of necessity spend many hours facing, at close range, alternate strips of white labels and dark jacks. To reduce the contrast between jacks and labels, experiments are in progress using paper labels tinted in quiet pastel shades. They have been arranged in an arbitrary pattern over the outgoing junction and trunk multiple, to help the operator to find the required route.

A similar result has been achieved with calling signals, by grouping circuits in batches according to the colour of label needed for operating purposes (for example, red for coin box) and using a pastel shade instead of white. We have yet to see whether the colours fade badly and whether they can be matched when new labels are needed.

New Facilities.—It sometimes happens that a subscriber with a P.M.B.X. wants an auxiliary automatic intercommunication system but does not need full P.A.B.X. working. The possibility of solving this problem by using a P.A.B.X. No. 2 in conjunction with, say, a P.M.B.X. 1A is being investigated.

★ ★ ★

"Restricted" Telephone Service.—The connection of new subscribers has been held up in some exchange areas in the past because the exchange is carrying a traffic overload at certain times of the day and additional calls cannot be handled until more exchange equipment is provided. To help in such cases, service is being offered on the condition that the lines will not be available for making outgoing calls during the busy periods. The arrangements vary in detail to suit the different circumstances at automatic exchanges, auto-manual exchanges and manual exchanges.

★ ★ ★

A Problem Find.—The object in this photograph was found on Bread and Cheese Hill, Thundersley, Essex, in 1948 and was subsequently handed in to Post Office Headquarters.

The National Telephone Company left its Oxford Court premises some 55 years ago and ceased to exist before the first World War, but the advertised reward of 5s. was paid to the finder and the key is being kept as a museum piece.

For those of us whose memories do not go back so far, the original use of these keys was a pretty puzzle, but it was eventually discovered that they used to be issued to members of the Stock Exchange and the Baltic and Wool Exchanges who wanted to be able to make trunk calls, from the special suites of call offices provided, after the attendants had gone off duty and locked up for the night.

International Conference.—The United Kingdom will be represented at the Plenipotentiary Conference of the International Telecommunication Union, which opens at Buenos Aires on October 1, by a delegation led by Sir Bertram Jerram, K.C.M.G. (Ambassador to Chile, 1949-1951) and including Col. A. H. Read, C.B., O.B.E., T.D., Director of Overseas Telecommunications, G.P.O., and eight other members of the Post Office staff.

The Post Office, on behalf of the United Kingdom, has put forward a number of proposals for the revision of the International Telecommunication Convention; similar proposals have been made by the remaining 86 members of the Union. The Conference is expected to last for two or three months; a revised convention will be signed and will probably come into force a year or so later, after it has been ratified by the governments.

The International Telecommunication Union was created at a conference in Madrid in 1932, as a fusion of the International Telegraph Union (1865) and the International Radiotelegraph Union (1906). The purpose of the International Telecommunication Union is to ensure uniformity of operating procedure, standardisation of equipment, and the proper regulation of the services. The constitution was considerably altered and expanded in 1949, following decisions taken at the Plenipotentiary Conference at Atlantic City in 1947.

An article "The Atlantic City Convention in Retrospect" appeared in the first issue of the *Post Office Telecommunications Journal* November, 1948.

★ ★ ★

Broadcast Relay Exchanges.—Sixteen licences to operate television relay exchanges have been issued, but the only service that has yet been developed is in Gloucester, where, at the end of March, 1952, 450 subscribers had been connected.

★ ★ ★

British Industries Fair.—The provision of adequate telephone facilities is specially important to both exhibitors and visitors at the British Industries Fair, which opened in London and Birmingham this year on the 5th May.

In London, 75 public call offices were provided at Earls Court and 45 at Olympia. The needs of individual exhibitors were served by more than 2,000 exchange lines—350 at Earls Court and 700 at Olympia.

At the Birmingham section of the Fair, a temporary manual telephone exchange named "Fair" was opened and remained open for some days after the Fair closed. This exchange had 650 subscribers. Eighteen kiosks were provided for local calls and six for trunk and international calls.

Special directories of exhibitors' telephone numbers were issued in London and Birmingham.

Teleprinter services linked the London section of the Fair with Cable and Wireless services at Electra House.

★ ★ ★

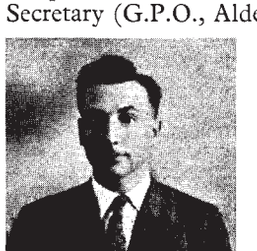
Removable Self-Sealing Coin Containers for Call Offices.—Experiments have been conducted with a removable self-sealing coin container for use in coin boxes in call offices. The container fits into the coin chamber at the base of the box; when it is inserted, the coin aperture in the container is automatically opened, but it shuts itself again when the container is withdrawn. Existing coin boxes do not normally need to be removed for the container to be fitted but can be adapted on site. Bulk supplies of the containers are being obtained and a programme of installations will shortly be drawn up.

★ ★ ★

I.P.O.E.E. Essay Competitions.—Every year since 1930, including the war years, the Institution of Post Office Electrical Engineers has held an essay competition, "to further interest in the performance of engineering duties and to encourage the expression of thought given to day-to-day departmental activities", for members of the Engineering Department below the rank of Inspector. Draughtsmen, Class II, with less than five years' service on that grade are also eligible to compete. The closing date is the 31st December.

In addition to five cash prizes, certificates of merit are awarded.

Any subject relevant to current telegraph or telephone practice will be accepted. A leaflet giving full particulars and hints can be obtained from the Secretary (G.P.O., Alder House, London, E.C.1).



J. C. Belcher, as a Technical Officer, won first prize in the 1951-52 competition, for "Radio Interference due to Non-Linear Circuit Elements". He is now an Assistant Engineer in Newcastle Area.

Telephone Accounts and Savings Stamps.—Telephone subscribers who wish to avoid having to find the whole amount due on six-monthly accounts at one time may sometimes find it convenient to purchase savings stamps in instalments and use them towards payment of their accounts. Savings stamps are not suitable to be sent through the post as remittances, but if a subscriber is willing to pay his account at a Post Office he can encash his savings stamps at the same time, in many offices as part of the same transaction.

Book Review

When the Lords Commissioners of His Majesty's Treasury authorised, in 1715, expenditure of 20s. a day on each of six Post Office Surveyors, they stipulated that the charge should be kept up "no longer than shall be absolutely necessary". Their Lordships showed little understanding of Post Office work, for 230 years were to pass before the Surveyors were found to be no longer "absolutely necessary".

For more than a couple of centuries, they were *Monarchs of All they Surveyed*—to use the title of their story, by two of them, J. T. Foxell and A. O. Spafford, published for the Postmaster General by Her Majesty's Stationery Office at 2s. 6d.—but it was the telephone that killed them; their autumn began in 1906, when plans were made to train them in telephony, ready for the take-over in 1912; the last Surveyor retired in 1943.

The writers seem to be rather overwhelmed by the idea of machinery replacing the more personal work of the old Surveyors. "The new machinery", they write, "is geared by complex rods and chains to the main source of power at Headquarters. With bearings well lubricated by the oil of conference, moving parts governed by circulating directives, power engendered by the ardour of the General Directorate and distributed by functional live wires, the career of the new engine opened with high hopes of useful service and scientific achievement." There remains, however, let us hope, some scope for that kind of individual initiative by which the Surveyors contributed so largely towards creating the Post Office of to-day.

Editorial Board. R. J. P. Harvey, C.B. (Chairman), Director of Inland Telecommunications; H. A. Ashton, C.B.E., Deputy Regional Director, North Western Region; C. O. Horn, Deputy Regional Director, London Telecommunications Region; A. F. James, Assistant Secretary, Personnel and Accommodation Department; A. Kemp, Assistant Secretary, Inland Telecommunications Department; Dr. W. G. Radley, C.B.E., Engineer-in-Chief; Col. A. H. Read, C.B., O.B.E., T.D., Director of Overseas Telecommunications; F. B. Savage (Assistant Editor), Public Relations Department; L. F. Watling, Public Relations Department; John L. Young (Editor), Public Relations Department.

Regional Representatives. E. A. Bracken, Welsh and Border Counties Region; W. G. N. Chew, Engineer-in-Chief's Office; W. D. Topley, Contracts Department; S. J. Giffen, Northern Ireland Region; J. E. Golothan, South Western Region; W. Millman, North Eastern Region; K. Ridehalgh, Home Counties Region; E. W. Sansom, London Telecommunications Region; H. Scarborough, Scotland; J. E. D. Stark, Midland Region; W. Tansley, North Western Region.

Publication and Price. This Journal is published in November, February, May and August. Price 1/-. The annual postal subscription rate is 4/6 post free to any address at home or overseas. (See announcement on page 127 of this issue.)

Copyright. Copyright of the contents of this Journal is reserved. Application for permission to reprint all or part of any article should be addressed to the Editor.

Advertisements. No official responsibility is accepted for any of the private or trade advertisements included in this publication. Communications, advertisement copy etc. should be addressed to Aubrey W. Hammond, Ltd., Spencers Farm, Horsham, Sussex. (Tel. Horsham 760.)

Contributions. The Editorial Board will be glad to consider articles of general interest within the telecommunication field. No guarantee of publication can be given. The ideal length of such articles would be 750, 1,500 or 2,000 words. The views of contributors are not necessarily those of the Board or of the Department.

Communications. Communications should be addressed to the Editor, Post Office Telecommunications Journal, Public Relations Department, Headquarters G.P.O., London, E.C.1. Telephone: HEAdquarters 4345. Remittances should be made payable to "The Postmaster General" and should be crossed "& Co."